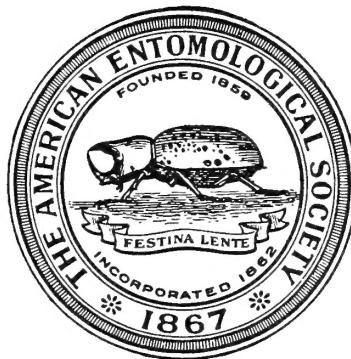


MEMOIRS
OF THE
AMERICAN ENTOMOLOGICAL SOCIETY
NUMBER 48

**THE GALL MIDGES (DIPTERA: CECIDOMYIIDAE)
OF HICKORIES (JUGLANDACEAE: CARYA)**

By

RAYMOND J. GAGNÉ



PUBLISHED BY THE AMERICAN ENTOMOLOGICAL SOCIETY
AT THE ACADEMY OF NATURAL SCIENCES
PHILADELPHIA

2008

The American Entomological Society

Philadelphia

Founded 1859

Incorporated 1862

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TRANSACTIONS OF THE AMERICAN ENTOMOLOGICAL SOCIETY are published in annual volumes of quarterly numbers. Subscription prices: United States \$30.00 per yearly volume (four issues); foreign countries \$34.00 per volume; U.S. and foreign members of the society \$15.00 per volume.

ENTOMOLOGICAL NEWS is published bimonthly except July–August. Subscription prices: \$30.00 per annual volume; foreign countries \$34.00 per volume; U.S. and foreign members of the society \$15.00 per volume.

MEMOIRS OF THE AMERICAN ENTOMOLOGICAL SOCIETY are published irregularly when a suitable monograph is submitted and accepted for publication. Prices vary with size; see back cover for list of available numbers.

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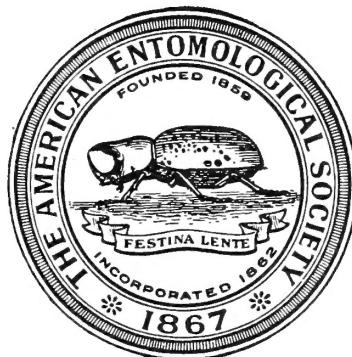
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Gift of the AES
November 2011



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Norman E. Woodley
Editor

Issued 15 September 2008

Composition by
Anne M. Landgraf
Brooklyn BookWorks
Brooklyn, Michigan

PRINTED IN THE UNITED STATES OF AMERICA

by
Sheridan Books
Chelsea, Michigan

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. . . The moon makes no protest. It rolls what it sees
into the scene it illumines, and lends its old weight-
afloat and paper thin and mottled with maria-
to what men have thrown up as it once beamed benign
on Crusader castles, fern swamps turning into coal,
and the black ocean when no microbe marred it.

—From *Condo Moon*, by John Updike

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**The Gall Midges (Diptera: Cecidomyiidae)
of Hickories (Juglandaceae: *Carya*)**

By

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ABSTRACT—This monograph treats the 63 species of gall midges known to feed on North American hickories (*Carya*: Juglandaceae). The distribution and history of hickories are outlined. Once widely dispersed across the Holarctic Region during the Eocene epoch and later, hickories are now limited in range to eastern North America and a smaller area in southeastern Asia. Fifty-six species belong to the single genus *Caryomyia* that is known exclusively from hickories. Each is univoltine and forms a characteristic, complex leaf gall in which their larvae eventually pupate the following spring. These species exhibit a great number of striking biological and morphological traits. Six other species in four other genera are responsible for one complex and five simple galls on the leaves or nut husks of hickories, while one other is an inquiline in galls formed by *Caryomyia* spp. Morphology, relationships, distribution, and biology of each of the gall midge taxa are treated in turn. Keys for the identification of hickory galls made by gall midges and to larvae of cecidomyiids on hickories are provided. Nineteen of the 63 species were previously named. Fifteen of them are redescribed and the remaining four are relegated to junior synonymy. One species is renamed and a new genus is described for another. Already described species are: *Caryomyia ansericollum* Gagné, **new name** for *Caryomyia caryaecola* Felt; *Caryomyia antennata* Felt; *Caryomyia caryaee* (Osten Sacken) (= *Caryomyia arcuaria* (Felt), **new synonym**); *Caryomyia caryaecola* (Osten Sacken); *Caryomyia cynipsea* (Osten Sacken); *Caryomyia holotricha* (Osten Sacken) (= *Caryomyia caryaee* (Felt), **new synonym**); *Caryomyia inanis* Felt; *Caryomyia persicoidea* (Osten Sacken); *Caryomyia sanguinolenta* (Osten Sacken); *Caryomyia tubicola* (Osten Sacken); *Caryomyia thompsoni* (Felt) (= *Caryomyia consobrina* Felt, *Caryomyia similis* Felt, **new synonyms**); *Gliaspilota glutinosa* (Osten Sacken), **new combination**; *Harmandiola nucicola* (Osten Sacken), **new combination**; and *Parallelodiplosis caryae* (Felt). Two **new genera**, *Caryadiplosis* and *Gliaspilota*, are described, as are 49 **new species**, as follows: *Caryadiplosis biconvexa*, *Caryadiplosis venicola*, *Caryomyia aggregata*, *Caryomyia albipilosa*, *Caryomyia arcuata*, *Caryomyia asteris*, *Caryomyia biretta*, *Caryomyia caminata*, *Caryomyia cilidolum*, *Caryomyia conoidea*, *Caryomyia cucurbitata*, *Caryomyia deflexipili*, *Caryomyia echinata*, *Caryomyia eumaris*, *Caryomyia flaticrustum*, *Caryomyia glauciglobus*, *Caryomyia glebosa*, *Caryomyia guttata*, *Caryomyia hirtidolum*, *Caryomyia hirtiglobus*, *Caryomyia inclinata*, *Caryomyia inflata*, *Caryomyia lenta*, *Caryomyia levicrustum*, *Caryomyia leviglobus*, *Caryomyia marginata*, *Caryomyia melicrustum*, *Caryomyia ovalis*, *Caryomyia procumbens*, *Caryomyia purpurea*, *Caryomyia recurvata*, *Caryomyia shmo*, *Caryomyia spherica*, *Caryomyia spiniglobus*, *Caryomyia spinulosa*, *Caryomyia stellata*, *Caryomyia striolacrustum*, *Caryomyia striolata*, *Caryomyia subulata*, *Caryomyia supina*, *Caryomyia tuberculata*, *Caryomyia tuberidolum*, *Caryomyia tumida*, *Caryomyia turbanella*, *Caryomyia turbinata*, *Caryomyia urnula*, *Caryomyia viscidolum*, *Contarinia bulliformis*, and *Contarinia cucumata*.

INTRODUCTION

Cecidomyiidae, the gall midges, are a large family of over 6,000 described species worldwide (Gagné 2004 & subsequently). They are of great economic and ecological interest because at least two-thirds of their number feed during their larval stage on flowering plants, some of agricultural and horticultural importance. Many cecidomyiids, by means of their larval salivary secretions, cause their hosts to produce galls that surround the larvae and produce their food. Except for the more economically important pests, however, Cecidomyiidae remain one of the least well known families of Diptera. A case in point is the present monograph on the gall midges of hickory. The number of species treated in this study is augmented from the 14 previously known from hickories to 63, 49 of them new to science.

The first notice of hickory gall midges was published in 1862 by Charles R. von Osten Sacken. A European amateur dipterist, he lived in the United States between 1856 and 1877, first as Secretary of the Russian Legation in Washington, later as Consul General of Russia in New York, and finally as a retired person before returning permanently to Europe (Osten Sacken 1904). His 1862 paper presented the first introductory sketch and synopsis of North American Cecidomyiidae. In that long article, still a delight to read for the simple, straightforward prose, Osten Sacken described and named many species of gall midges he found in the vicinity of Washington, DC. Among his discoveries was a suite of eight species from hickories. Seven of them form complex, detachable leaf galls and belong to the genus *Caryomyia*. The eighth species causes a sticky leaf spot and is placed here in a new genus, *Gliaspilota*. Osten Sacken reared the adult stage from only one of the detachable galls; all the remaining species were described chiefly from their galls, with a line or two on the larvae of some. In 1870 Osten Sacken described a ninth species, placed here in *Harmandiola*, from swellings on hickory nut husks and associated larvae that he collected in Rhinebeck, New York.

Additional species from hickory were named between 1907 and 1921 by Ephraim Porter Felt, distinguished State Entomologist of New York from 1898 to 1928. Felt was involved with many statewide insect problems, including mosquitoes and shade tree insects, but as a major side interest

while State Entomologist and afterwards he named 1080 species of gall midges from North America and elsewhere. That number is phenomenal, even taking into account the standards of the day, but the accomplishment left him little time to reexamine the body of work as it grew. He nonetheless left to posterity an overall well-mounted and labelled collection of type material as well as a major work on galls, *Plant Galls and Gall Makers* (Felt 1940). The book is somewhat dated, but still useful and unique in that it treated all of the North American insect and mite gall makers known to 1940, including what are still the more noticeable and common gall makers of our fauna. Felt acknowledged Osten Sacken's species and named nine more from hickory, all from the Albany, New York, vicinity except one from Massachusetts. Two species were based on adults netted on hickory (Felt 1907) and the remaining seven were reared from galls (Felt 1908, 1909, 1921), but his association of the reared species with particular galls wavered in consecutive papers. Felt (1909) proposed the name *Caryomyia* for the hickory gall midges and later (Felt 1921) gave an overview of the included species. Four of Felt's nine species are treated as junior synonyms here, and another, a junior homonym, is renamed.

Notices of some of these Osten Sacken and Felt species were published subsequently, including summaries in Felt (1940), the posthumous Felt (1958) (as revised by Remington & Remington), and Gagné (1989), but only one further study, by Bertram W. Wells (1916), treated the cecidomyiid-caused hickory galls in a comprehensive manner. Fascinated by gall architecture while a botany student and later assistant professor at Ohio State University, Wells published several papers on galls. In his 1916 paper, he made effective drawings, whole and in section, of 28 kinds of cecidomyiid hickory galls that he collected, mainly in southeastern Ohio. His two plates are reproduced here as Figures 1–33. Wells's drawings of galls in longitudinal section demonstrated the importance of internal gall structure, including wall thickness, any intrusions from the exterior, and how each is attached to the leaf. He attempted to assign Osten Sacken's and Felt's species names to the galls but refrained from coining new names himself because he believed that task should be done by those studying the insects (Wells 1916). Wells subsequently moved to North Carolina

where he distinguished himself in the field of plant ecology. Following his 1916 paper and the review by Felt (1921), essentially nothing new has been published on hickory gall midges for these last eighty-seven years.

Table 2, pp. 17–18, lists the 63 species of Cecidomyiidae known to feed on American hickories, all but one responsible for specific galls. They belong to six separate genera and show remarkable morphological diversity and a variety of life strategies. The genera are as follows:

Caryomyia. This genus comprises 56 species found exclusively on hickories. Each species forms a distinctive complex leaf gall that usually dehisces between spring and fall (Figs. 36–164). Larvae remain in their galls over winter and pupate the following spring.

Caryadiplosis. This is a new genus that appears to be the closest known relative of *Caryomyia*. It contains two new species that make simple galls, one a circular, biconvex leaf blister (Figs. 167–168), the other a vein or petiole swelling (Figs. 165–166). When fully fed, larvae exit the galls and drop to the soil where they overwinter and then pupate the following spring.

Contarinia. To this large group in its broad sense are added two new species known only from their larvae. One species forms a complex sac-like leaf gall (Figs. 172–173) in spring on several hickories, the other causes a bubble leaf blister (Figs. 170–171) on pecan.

Gliaspilota. This new genus is described for *Cecidomyia glutinosa* (Osten Sacken). Larvae of this species live freely on mucilaginous leaf spots that appear on the underside of new leaves in spring (Figs. 175–177). Fully-fed larvae soon drop to the soil to pupate and then emerge as adults the following year.

Harmandiola. Until recently this group comprised several gall-formers on poplars and chestnuts. It now includes one other species, *Harmandiola nucicola* (Osten Sacken), from hickory. Larvae form swellings on nut husks (Figs. 178–180). Fully grown larvae drop to the soil to overwinter.

Parallelodiplosis. A number of species in this genus live as parasitoids in galls formed by other gall midges and cynipids. One, *Parallelodiplosis caryaee* (Felt), lives in galls of various species of *Caryomyia* (Fig. 48). This species may have more than one generation per year.

In addition to the taxa listed above, undetermined species of two additional genera were

found. These genera are included in the larval key provided farther on but are not treated further in this paper except to list them here, as follows:

Lestodiplosis. This is a large worldwide genus of over 160 described species that feed as larvae on insects and mites (Gagné 2004). Larvae of several species were found during this study on the surface of hickory leaves or in galls caused by *Caryomyia*, *Phylloxera* (Phylloxeridae), and various groups of mites (Acarina). Larvae are shown in Figs. 48 and 53. These predaceous larvae and the few adults reared from them during the present study cannot now be identified with confidence without a separate revision of *Lestodiplosis*.

Dasineura. This is the largest genus of gall midges, a catchall category with more than 460 described species (Gagné 2004). On one occasion in early May, 2005, two full-grown larvae were found closely appressed to an expanding leaflet of mockernut hickory. The larvae were not associated with any apparent damage.

THE HICKORIES

Hickories belong to *Carya*, a genus of the walnut family (Juglandaceae) that contains 12 North American species including pecan. The present range of the genus encompasses the eastern half of temperate North America, including southern Ontario and Quebec, eastern United States, and isolated areas in the mountains of northeastern Mexico, as well as parts of southeastern Asia (Grauke 2003, Manchester 1987, Stone 1990). The 12 North American hickories form two sections, *Apocarya* with four species and *Eucarya* with eight species and one variety (Table 1, p. 4). Additional *Carya* spp. occur in southeast Asia, three to six species depending on the authority, and belong to a third section, *Sinocarya* (Stone 1997). No galls from Asian species have been reported and no sign of galls occurs on leaflets of their representatives in the herbarium of the National Museum of Natural History, Smithsonian Institution, Washington, DC, so the present study treats only the gall midges of North American hickories.

Hickories are now used chiefly for firewood or charcoal-making, but their tough, resilient wood was once more commonly used for such things as spokes for wagon wheels and tool handles (Grauke 2003). Pecan, originally a Mississippi basin species, is now widely planted and culti-

Table 1. Scientific and common names of North American *Carya* species (from Stone 1997). The correct name for the section *Eucarya* is *Carya*, but *Eucarya* is used in this paper to avoid confusion with the generic name.

Section *Apocarya*:

<i>C. aquatica</i> (F. Michaux) Nuttall	water hickory
<i>C. cordiformis</i> (Wangenh.) K. Koch	bitternut
<i>C. illinoiensis</i> (Wangenh.) K. Koch	pecan
<i>C. palmeri</i> Manning	Mexican bitternut

Section *Carya* or *Eucarya*:

<i>C. floridana</i> Sargent	scrub hickory
<i>C. glabra</i> (Miller) Sweet	pignut
<i>C. laciniosa</i> (F. Michaux) Loudon	shellbark
<i>C. myristiciformis</i> (F. Michaux) Nuttall	nutmeg hickory
<i>C. ovata</i> (Mill.) K. Koch	shagbark
<i>C. ovata</i> var. <i>mexicana</i> (Helmsley) W.E. Manning	Mexican hickory
<i>C. pallida</i> (Ashe) Engler & Graebner	sand hickory
<i>C. texana</i> Buckley	black hickory
<i>C. tomentosa</i> (Poiret) Nuttall	mockernut

vated throughout southeastern United States and abroad for its nutmeat. Shagbark and white hickories, especially north of the range of pecan, still have some value to people for their nutmeat. All are important to wildlife, particularly tree squirrels (Manchester 1987).

The name “*Carya*” is Greek for walnut. The common name “hickory” is derived from the American aboriginal word “pawcahiccora” for a mash made from the nutmeat. The word was shortened to hickory for the name of the tree by the early English colonists. “Pecan” is another American aboriginal word meaning “hard-shelled nut.”

Only one other genus of Juglandaceae, *Juglans* or walnut, occurs in North America. It is widely distributed throughout the temperate Holarctic Region. The only gall midges recorded from *Juglans* across its entire range are two undescribed eastern North American species that live as larvae in marginal rolls of leaflets, one a *Dasineura* on *Juglans nigra*, or black walnut, the other a *Contarinia* on *Juglans cinerea*, or butternut (Gagné 1989).

Hickories are an ancient genus that was once much more widely dispersed. *Carya*-like pollen is known from the early Paleocene, about 60 million years before the present (bp), but the earliest recognizable *Carya* fossil fruit is from mid-Eocene

Europe about 45 million years bp (Manchester 1987, Stone 1990). Post-Eocene hickories extended across the Northern Hemisphere until after the mid-Miocene (ca. 15 million years bp), when the climate cooled and the individual elements of a once uniform Arcto-Tertiary forest began to separate and undergo extinctions (Wolfe & Leopold 1967). Fossil *Carya* fruit have been found in Alaska (Lower Miocene), Washington state (Miocene) and Colorado (Lower Oligocene), as well as in Eurasia (Middle Eocene to Pliocene) from central and eastern Europe, western Siberia, northern China, and Japan (Wolfe & Leopold 1967, Manchester 1987). The present narrow range of the genus is due to extinctions during the uppermost Tertiary and Pleistocene (Manchester 1987).

During the Pleistocene glacial maxima, hickories and other deciduous trees were much more severely restricted in range than presently. Deciduous angiosperm trees survived in small, isolated populations in the lower Mississippi valley and on the southern coastal plain among the more widespread conifers, as determined by pollen deposits in lake beds (Davis 1983, Delcourt and Delcourt 1984). When the glaciers of the most recent ice age began to recede about 12,000 years ago, the various tree species that survived gradually spread north on a species basis and not as com-

munities, their individual paths dependent upon their particular refugia and individual strategies (Davis 1983). Moving from southwest to northeast, *Carya* expanded more slowly than some other genera, in part because of their heavy fruit; even so, hickories arrived early (10,000 bp) in the upper midwest at sites close to their present northern boundary, but were slow to cross the Appalachian Mountains, arriving in New England only about 5,000 years bp (Davis 1983).

Populations of hickories in Mexico (Map 1) may not have been greatly affected by glaciation. Hickories there are part of an assemblage of deciduous trees generically similar to that of eastern North America. This representation of northern trees in Mexico appears to have been in place since the mid-Miocene when the cooling continental climate allowed the deciduous forest to reach so far south (Graham 1999). Evidence for this is that pollen and spore deposits in Mexico show a late Cenozoic history of the assemblage's presence there. In addition, it is unlikely that the soil between central Texas and the relict populations in Mexico would have supported a rich deciduous forest more recently than the mid-Miocene (Graham 1999). These points will be of interest farther along when considering the relative absence of galls on a Mexican population of *Carya ovata* var. *mexicana*.

North American hickories vary greatly in distribution. A few species, *C. cordiformis*, *C. glabra*, *C. ovata*, and *C. tomentosa*, range widely and occupy most of the combined range of the genus in Canada and the United States indicated in Map 1. The remaining species, except pecan, *Carya illinoiensis*, which has been extensively planted for commerce, are restricted to small parts of the combined range (Elias 1980).

MATERIALS AND METHODS

Hickory names and identifications.—In discussions that refer to both *Carya* and *Caryomyia* or *Caryadiplosis*, the abbreviation "C." is used to mean *Caryomyia* or *Caryadiplosis*; in those discussions I use the common names of the hosts to avoid confusion. Both scientific and common names of hickories are listed in Table 1. Hickory identifications were made with the use of various keys and treatments, including those of Brown & Brown (1972), Elias (1980), Gleason (1963), Grauke

& Pratt (1986), and Stone (1997). Keys do not all agree in the number of species. After gaining some experience I followed Elias (1980), Grauke & Pratt (1986), and Stone (1997) in which *Carya ovalis* is placed under *C. glabra* and *C. septentrionalis* under *C. ovata*. Hickories are highly prone to hybridization (Grauke 1988, 2003) and one notices considerable variation in this genus, but only rarely did I encounter a tree not readily attributable to a species. As it happens, most cecidomyiids in this study do not appear to discern among hickories, particularly those feeding on the *Eucarya* section.

Collections.—Most galls and their cecidomyiids used for this study were collected by me since 1993. Observations and collections were largely made at many sites within 20 miles of my residence in Silver Spring, Maryland and at one site near Hedgesville, West Virginia. A major local area sampled was the Beltsville Agricultural Research Center in Beltsville, Maryland where trees remained undisturbed during this time period and where I was free to collect as an employee of the U.S. Department of Agriculture. I made three separate circuit trips across midwestern and southern United States to collect galls, two separate trips to Florida, several to New England and New York, including once an extension into Ontario, and one trip to Tamaulipas, Mexico with a stop on the way to southeastern Texas. Additional collections were made for me by collaborators in Connecticut, Georgia, and Florida. In addition, I studied types and other specimens from the Felt Collection, which is the property of the New York State Museum in Albany but currently on loan to the Systematic Entomology Laboratory in Washington, DC, and the few miscellaneous specimens, including the existing Osten Sacken types, deposited over the years in the National Museum of Natural History, Washington, DC.

One needs to cover a lot of ground to find hickories with galls, especially the less common ones. The best collection sites were forest edges or open-grown trees where low-hanging branches made collecting convenient. Sampling while traveling is always haphazard, dependent on a place to park a car or obtaining permission from property owners. Old churchyards, cemeteries, and interstate highway rest stops, particularly the large midwestern ones, are productive sites. Paths through woods are not as good when time is pressing because finding hickories can be uncer-

tain and branches in forests are often too high to reach. Some good collecting sites in central Maryland were lost to development over the course of this work: one site is now a public ice skating rink with large adjacent parking lot, and another a shopping center.

Collecting consisted of harvesting gall-bearing leaflets and placing them in a plastic bag with a locality and host label. I gathered galls at a site until I had a sufficient number of the available kinds. Because these galls are small, close examination was done subsequently, usually in the evening of the same day with the aid of a dissecting microscope. Representative galls were cut open and the larvae removed and saved in alcohol. Samples of whole and cross-sectioned galls were glued to a card and pinned together with a data label for permanent reference. Remaining galls that were excess but not numerous enough to attempt to rear were kept dry in labelled plastic bags for future comparison and extraction of larvae as needed. Larval samples were placed in alcohol and labelled, some eventually to be slide mounted or used for SEM photos. At the proper season, depending on the species, galls with full-grown larvae or, for genera other than *Caryomyia*, larvae that had escaped the galls, were kept through winter to rear adults. Some reared adults were pinned but most were kept in 70% ethyl alcohol for eventual slide mounting.

Sweeping or otherwise trapping adults in flight is not practical. Associating both sexes of a species is usually not possible for most plant-feeding gall midges unless they are reared together from similar galls. Any sweep of hickory branches can yield many species of gall midges, some just passing by and having nothing to do with hickory. While gall midges caught in flight may with practice be identifiable to generic level when viewed dried or in alcohol, they must be painstakingly mounted on microscope slides for further critical viewing, and even then most flight-caught phytophagous cecidomyiids cannot usually be determined beyond genus with confidence. Slide mounting is a time-consuming activity better spent on reared samples. The best method for obtaining adults of phytophagous gall midges is to collect a sufficiency of galls before they begin dropping from the trees, usually in September and October for hickory galls, and keep them over the winter. Galls with full-grown larvae are placed in pots filled with dampened

peat moss. If larvae normally exit the galls when full grown, they will crawl into the peat moss. In this way it is possible to obtain all stages of a species and learn something of their biology. Even so, I was unable to rear adults or obtain pupae of all of the species treated here. Many larvae die from parasitism or other causes before they are fully developed, so one needs a large number of galls to successfully obtain gall midge pupae and adults. Galls of the less common species were never found in sufficiently large numbers to successfully rear adults.

Adult rearing.—I have tried various methods to rear adults but that outlined in Gagné (1989, 1994) still works satisfactorily, with one change. I place galls, or larvae when these escape the galls to pupate in the soil, in pots filled with dampened peat moss and place them in an outdoor cold frame for the winter. Many galls in that situation undergo deterioration from the dampness and fungi, allowing entry by various arthropods, mainly mites and sciarids. This is probably no different than what happens in nature, but it means that one has to have a large number of galls to insure success. At the end of February when I bring the pots indoors, I place each pot in a separate clear plastic bag. The bag is large enough to spread well away from the pot at the bottom so any emerging specimens are noticeable when the bag is held against the light. The top of the bag is closed by bringing together two ends of the opening in a simple knot. Condensation does not collect on the inside of the bag if the pot is not overly wet in the first place and the bag is kept out of direct sunlight. If moisture does condense on the inside of the bag, a wet bag can be changed repeatedly to a dry one until the pot loses the excess moisture. This seems to be a more efficient method than the one I formerly used, when I placed the pots individually in cardboard shoe-boxes, each with a vial fit tightly into an opening at the end. With that method I occasionally lost some specimens that could squeeze out through a cover that did not fit tightly or escape when I opened the cover for a peek.

Specimens examined and their preparation.—Slide mounting of specimens follows the technique in Gagné (1989, 1994) using Canada balsam. Most of the larvae and adults studied during this study can be traced to particular galls that are either on pinned cards or in alcohol. Holotypes of new species and remaining specimens used in this

study, except those from the Felt Collection, are deposited in the insect collection of the National Museum of Natural History in Washington, DC (USNM).

Descriptions.—In the species descriptions that follow, the gall is described first because it is the most obvious manifestation of a species. Each gall description lists elements of the mature gall in this order: frequency (common, occasional, or rare), distribution on hickories (*Apocarya* or *Eucarya* section or both); arrangement of galls on a leaflet (single or clustered), position on a leaflet (upper or lower leaf surface, between or on veins); height or length in mm and external shape; external texture; connection to the leaflet; wall structure in longitudinal section; and shape and texture of the larval chamber. A concluding sentence or two usually follows to differentiate the gall from other galls with which it might be confused.

Some species are named and described here on the basis of only the gall and larva because during the period of this study I did not succeed in rearing the adult. In a comprehensive study the absence of adults of some species should not preclude describing species from larvae alone. Larvae have good distinguishing characters, their biology and hosts are known, and their characteristic galls can be found again, possibly to successfully rear adults.

Adult abdominal tergal setation is described from the third tergum posteriad because the posterior setal rows of the first and second tergites are always discontinuous mesally. Larial length offers a rough size estimate. In any instar a larva grows considerably, so the larger number of the range is the more meaningful one.

Lists of collection and specimen localities.—Collection localities of galls of each cecidomyiid species in this revision are listed alphabetically by state or province and county or town. Voucher specimens for the gall records are deposited in the USNM, either pinned or in alcohol. Listed also, with citations, are galls from publications when accompanied by identifiable figures. A separate list of larvae, pupae, and adults of each species studied gives the collection and rearing (if any) data in alphabetical order by state or province, and town or other site, followed by collection date, collector if not me, and the associated life stage. All these specimens, including types of new species, but excepting the Felt Collection specimens, are deposited in the USNM. Abbreviations

include: For. = Forest; Mt. = Mountain; Natl = National; MCZ = Museum of Comparative Zoology, Cambridge, Massachusetts; Ref. = Refuge; St. = State; USDA = U.S. Department of Agriculture; USNM = National Museum of Natural History, Smithsonian Institution, Washington, DC.

Species concept within *Caryomyia*.—I considered a distinct gall the phenotypic extension of a discrete species. In only one case might the gall distinction seem minor, viz. between *C. leviglobus* and *C. spiniglobus*. The first (Fig. 62) has a smooth exterior, the other (Fig. 64) is covered with stiff setae. Because the two kinds were never found interspersed, I consider the gall makers distinct, even though I cannot separate them morphologically. Two other species are noteworthy here because of their variability. *Caryomyia thompsoni* has two distinct variations in gall surface, one kind more or less sparsely haired and the gall surface visible (Fig. 113), the other with thick hair obscuring the gall surface (Fig. 114). These can often be found interspersed on a leaflet (Fig. 112), and the morphology of *Caryomyia* specimens from each is indistinguishable. Except for the type specimens under the species name, I made no further distinction in the list between the two kinds and considered them to be made by the same species. The other special case is *C. caryae*, in which the galls intergrade. The extreme forms (cf. Figs. 55–56 with Figs. 57–58) each seen alone certainly appear different and I might have treated them as separate species were it not for commonly found intergrades. No differences in any stage of the gall midge from the two extremes of galls could be detected.

GENUS CARYOMYIA FELT

Caryomyia Felt 1909: 292. Type species, *Cecidomyia tubicola* Osten Sacken, by original designation. Felt 1911: 56 (review); Felt 1921: 94 (review); Gagné 2004: 100 (catalog).

Diagnosis.—This genus may be differentiated from other genera of Cecidomyiidae by the following combination of characters: Adult without dorsal protuberance on occiput; wing (Fig. 245) broadest on basal half, C unbroken at juncture with R₅; legs considerably foreshortened (Fig. 183), shorter than wing length; abdominal sternites lacking anterior pair of trichoid sensilla; gonostylus short, broad, with wide tooth; protrusible ovipositor ta-

pered abruptly beyond eighth segment, short, the ninth tergite dorsally with narrow, pigmented, stiff, dermal structure, and cerci partially fused dorsally at base (Figs. 184–185). Larva with only 1–4 lateral papillae; dorsal thoracic papillae reduced to 4; terminal papillae all similar, flat or convex, setose (Fig. 271).

Description.—**Adult:** **Head:** Eyes connate; facets mostly hexagonoid and closely adjacent except slightly farther apart and circular at mid-height of head. Occiput without dorsal protuberance. Frons setose. Labrum with or without setae. Labella separate or coalesced, with or without setae. Palpus 1- to 4-segmented. Antenna with 12–20 flagellomeres, when 12, often with an additional bud at apex of twelfth counted as a thirteenth, but this one without circumfila; male flagellomeres (Figs. 235, 237, 239) generally foreshortened, bimodal with foreshortened internodes and necks, or cylindrical (Fig. 240) and lacking internodes and necks; either with 3 circumfila, 1 on basal node and 2 on distal node, or the 3 evenly distributed along flagellomere length, loops of the circumfila subequal in length, short, not attaining bases of next distal circumfilum, rarely a loop connected between two circumfila, or with 9–10 interconnected horizontal circumfila; female flagellomeres (Figs. 236, 238, 241) each progressively shorter, cylindrical with short necks, ringed with 2 appressed circumfila connected by two longitudinal bands or several anastomozing bands. **Thorax:** Scutum with 4 longitudinal rows of setae. Scutellum with lateral group of setae on each side. Pleura with vestiture only on setose mesepimeron. Wing (Fig. 245) broadest on basal half, unmarked, width 0.4–0.5 wing length; C unbroken at juncture with R₅; R₅ curved apically, joining C posterior to wing apex; Rs incomplete, closer to arculus than to apex of R₁. Legs generally foreshortened, femora, tibiae and tarsi of approximately equal length or progressively shorter from femora to tarsi. Tarsal claws (Fig. 246) untoothed, curved beyond midlength; empodia as long as claws; pulvilli minute, much shorter than claws. **Male abdomen:** First through seventh tergites entire, rectangular, about 5 times as wide as long; with setae in 1–4 rows along posterior margin or only posterolaterally and with anterior pair of trichoid sensilla but no other vestiture except for microsetulae entirely covering sclerites; eighth tergite may be more weakly sclerotized than preceding tergites and have fewer setae; tenth tergum with narrow, elong-

gate, stiff, pigmented dermal structure along its length. Sternites rectangular, 2–3 times as wide as long, without trichoid sensilla; second through sixth sternites with horizontal row or rows of posterior setae and variable horizontal rows of mostly shorter setae near midlength; seventh and eighth sternites with more numerous setae and both rows adjacent. Genitalia (Figs. 186, 247–257): cerci short, broad, with setae along margin; hypoproct parallel-sided to broadly widened posteriorly, with scattered short setae along posterior and lateral edges, covered with setulae except, in most species, dorsum bare from base to posterior third or fourth; aedeagus tapering from base to apex or broad, cylindrical, rounded or notched apically; gonocoxite cylindrical, short, broad; gonostylus short, broad, ovate, with dense setae and entirely setulose. **Female abdomen** (Figs. 183–185): First through eighth tergites entire, rectangular, about 6 times as wide as long; vestiture as in male. Second through seventh sternites rectangular, about 2.5 times as wide as long, vestiture as in male. Ovipositor slightly protrusible, soft to rigid, gradually tapering beyond eighth segment; ninth tergite dorsally with narrow, pigmented, stiff dermal sclerite, laterally and ventrally setose; cerci ovoid or triangular, partially fused anterodorsally, covered with setae but without distal peglike setae; hypoproct short, broad, with 2 posterior setae.

Pupa (Figs. 187–214, 267–268): Integument unpigmented. **Head:** Vertex convex, on each side with anterolateral pair of papillae, one of each pair, occasionally both, with conspicuous seta. Antennal bases forming anteriorly directed horns of various length and shape. Anteriormost angles of face between antennal bases and flagella often convex. Face anterior to midlength smooth or indented with an extruded posterior lip on each side. Frons and clypeus convex or conspicuously expanded, base of frons with pair of setose papillae. Labella triangular, convex. **Thorax:** Prothoracic spiracles elongate, pointed. Thoracic papillae short-setose, situated on each side as follows: 1 on prothorax anterior and medial to spiracles, 3 along anterior edge of notum, 1 anterior to wing base, and one at posterior end of notum. Notum with row of tiny spicules on each side of medial suture. Wing pads extending just beyond second abdominal segment, legs extending approximately to end of third abdominal segment. **Abdomen:** Spiracles sessile. First abdominal tergum of all species covered with short spicules and additionally with horizontal

row of 6 short-setose papillae barely longer than spicules; intersegmental tergal areas smooth, bare; second through eighth tergites as for first or with several horizontal rows of large, closely set, spine-like spicules on anterior third of segment. Pleura smooth anteriorly and posteriorly but elsewhere covered with small spicules, a pair of setose papillae present similar to those on terga. Sterna wrinkled, rough, with minute pointed verrucae anteriorly and laterally, papillae not detected.

Larva: Third instar (Figs. 215–231, 269–271): White, cylindrical to ovoid, anterior and posterior ends rounded or tapered. Head directed anteriorly or ventrally. Antenna about twice as long as wide. Spatula (Figs. 274–327) present, variously shaped. Papillae with or without setae, their bases prominent or not. Lateral papillae 1–4. Ventral papilla on each side of spatula closely adjacent to lateral papillae. Dorsal papillae of thorax 4, of first through seventh abdominal segments 4–6. First through eighth abdominal segments always with verrucae laterally, dorsum and venter smooth or lined and/or variously covered with rounded to pointed verrucae and ventrally with rounded verrucae or pointed spicules. Terminal segment of same length to more than twice as long as eighth abdominal segment, with 8 similar papillae without setae, 4 on each side, slightly to conspicuously convex. Anal region with 0–2 papillae. **Second instar** (272–273): White, ovoid. Head directed anteriorly or ventrally. Antenna about twice as long as wide. Spatula present in all species except *C. albipilosa* and *C. striolata*, with apically pointed tooth and elliptical to quadrate shaft. When spatula present, collar segment on each side with patch of enlarged spicules. Papillae with or without setae, their bases prominently raised or not. Lateral papillae 1–4. Dorsal papillae of thorax 4, of first through seventh abdominal segments 4–6. First through eighth abdominal segments variously covered dorsally with rounded and or pointed verrucae. **First instar** (Fig. 35): Translucent to white, fusiform at first, becoming flattened and discoid. Spiracles present on first thoracic and eighth abdominal segments only. Antenna about three times as long as wide.

Egg (Fig. 34): Elongate-ovoid, red.

AFFINITIES

Caryomyia belongs to the supertribe Cecidomyiidi because of the separate many-looped

circumfila of the male flagellomeres (Gagné 1989, 1994). Below that level the genus fits into the large tribe Cecidomyiini that contains most of the Holarctic plant-feeding Cecidomyiidi, mostly genera that lack a dorsal occipital protuberance, have usually simple tarsal claws that are curved beyond midlength, and larvae with a particular makeup of the terminal papillae (Gagné 1989). While Cecidomyiini typically have four pairs of terminal papillae, three of them short-setose and the other corniform, enlarged, and recurved dorsally (as in Fig. 334), all eight terminal papillae of *Caryomyia* are without setae and similar in appearance (Fig. 271). The relationship of the genus to other Cecidomyiini is nonetheless clear due to the fortunate discovery during this study of the new genus *Caryadiplosis* that is described below. While the two genera are evidently related due to shared, derived adult characters, *Caryadiplosis* has retained the larval form commonly found in the tribe. In the key to genera of Cecidomyiidae in Gagné (1981), *Caryomyia* runs to couplet 135 with *Contarinia*, but that placement does not argue for any affinity between those two genera.

Felt (1909) first described *Caryomyia* to include eight species and eventually added another seven (Felt 1921). Three were included only for convenience because they occurred on hickories. Felt (1909, 1921) wrote that *Caryomyia* bore some resemblance to *Planetella* (as *Hormomyia*), but the only grounds he offered was that the two genera shared "somewhat the appearance," a suggestion that does not bear scrutiny. Felt (1921) later wrote that *Caryomyia* might be a relative of *Polystepha* (as *Cincticornia*), a genus in the tribe Asphondyliini, because the male antennal circumfila of both genera are short and *Carya* and *Quercus*, the host of *Polystepha*, are somewhat related. Because of this, *Caryomyia* was listed in Felt (1958) with the tribe Asphondyliini, and that placement was continued in Foote (1965). Male antennal flagellomeres and their circumfila are foreshortened in some species of *Caryomyia* that Felt knew (Fig. 237), but had he seen a male of the *Caryomyia cilidolum* group with its reticulated flagellomeres (Fig. 240) he would have had better but still superficial support. The antennae of the *C. cilidolum* species group are generally similar to those found in several species of *Polystepha* spp. (cf. Fig. 30a, p. 154 of Felt 1916). We now know that the two genera are in separate tribes because *Polystepha* shares a number of apomorphies with the Asphondyliini

(Möhn 1961, Gagné 1994), the most important being the enlarged female seventh sternite. That the antennae of two groups of species in two separate tribes are so similar is only one more example of adaptive homoplasy that can be found in Cecidomyiidae. Other examples of parallel modifications are listed in the following discussion. These serve as a good argument for comprehensive revisions, in which context these happenstances can be appreciated better.

A relationship between *Caryomyia* and *Caryadiplosis* is supported by three synapomorphies and one other character they have in common. The first synapomorphy is the presence of a narrow, elongate, dorsal sclerite on the female ninth segment, the posterior, more rigid half of the ovipositor (Figs. 258–264, 331). Both genera have protrusible, yet relatively short ovipositors on which the structure is presumably used as a stiffener. I know of a corresponding structure on only two other genera of Cecidomyiini, *Macrodiplosis* and *Paradiplosis*. *Macrodiplosis*, a large genus of leaf gall makers on oaks (Gagné 1989), has a relatively short ovipositor also, but the stiffener extends only along the posterior two-thirds of the segment. In *Paradiplosis*, a genus of four species on fir and spruce, the ovipositor is extremely long (Osgood and Gagné 1978).

The second synapomorphy is the unbroken costal vein at its junction with R₅. An unbroken costal wing vein is rare in Cecidomyiini and unknown in other tribes of the supertribe Cecidomyiidi. The trait occurs in two cecidomyiine genera that infest Pinaceae, *Paradiplosis* and *Thecodiplosis*, neither of which seems especially closely related to one another or to *Caryomyia* and *Caryadiplosis*, so I suppose the closed costa evolved independently in this tribe at least three times. *Macrodiplosis*, mentioned in the previous paragraph, has a broken costa.

The third synapomorphy is the apparent loss of a pair of peglike sensilla usually found near the apex of the female cerci. Almost all Cecidomyiidi have these two (sometimes more) distinctive sensilla that have broad sockets and wide, blunt-tipped setae (as in Fig. 362). *Paradiplosis* and *Thecodiplosis* both have the pair of sensilla.

Another character *Caryomyia* and *Caryadiplosis* have in common is a completely setulose gonostylus, but I cannot say with confidence whether this is primitive or derived. The alternative state, the

gonostylus setulose only on the basal half and longitudinally ridged beyond, is the one most commonly found in the subfamily Cecidomyiinae, including *Macrodiplosis* and *Thecodiplosis*, but not *Paradiplosis*. A completely setulose gonostylus is definitely the less common state in Cecidomyiini. It will be noticed that *Paradiplosis* shares at least three characters with *Caryomyia* and *Caryadiplosis*: a sclerite on the distal half of the ovipositor, the unbroken costal vein, and the completely setulose gonostylus. This genus is discussed further under *Caryadiplosis*.

Caryomyia differs from *Caryadiplosis* in many ways, presumably all apomorphic, as follows:

1. Galls are complex, the result of a complete restructuring of the host tissue, instead of simple swellings.
2. Larvae have only one to four lateral thoracic papillae on each side of the midline (Fig. 274) instead of six lateral thoracic papillae in two triplets on each side (Figs. 335). Such reduction is not uncommon in Cecidomyiinae that form galls, especially complex galls, but the full complement is the rule in non-phytophagous Cecidomyiinae.
3. Larvae have only four instead of six thoracic dorsal papillae. Except for *Caryomyia*, all other Cecidomyiidi known to me have six dorsal thoracic papillae. I know of a similar reduction in two genera, *Asteromyia* (Gagné 1968) and *Semudobia* (Roskam 1977), both members of the supertribe Lasiopteridi but in separate tribes.
4. The larval terminal papillae are all similar and asetose (Fig. 271), instead of dissimilar and either setose or corniform (Fig. 334). This reduction is unique in Cecidomyiidi.
5. Pupation occurs in the gall rather than in the soil.
6. Adult tarsi of *Caryomyia* are foreshortened, no longer than the tibiae and 0.33 or shorter than the entire leg, while in *Caryadiplosis* and most other Cecidomyiini the tarsi are appreciably longer than the tibiae and 0.40 or more than the entire leg.
7. Adult abdominal tergites have neither a lateral group of setae (setae that lie just anterior to but separate from the posterior row of setae) nor scales (Fig. 258). In *Caryadiplosis* and most other Cecidomyiini, these setae and scales are usually present (seen in Fig. 330).

8. Adult abdominal sternites lack an anterior pair of trichoid sensilla (Fig. 330). Their loss here appears to be unique in *Cecidomyiini*.
9. The male ninth tergum has a narrow, elongate sclerite along the midline (Figs. 248–249). In my experience, the presence in *Caryomyia* of this sclerite is unique.

As to apomorphies of *Caryadiplosis*, there are possibly two, the presence of a midlength horizontal ridge on the male hypoproct (Fig. 333) and the short, wide, cylindrical aedeagus (Fig. 333). *Caryomyia* and other *Cecidomyiini* known to me have no horizontal ridge at midlength on the hypoproct (Fig. 247), and I know of no other cecidomyiine with a similar aedeagus.

INTRAGENERIC MORPHOLOGY AND RELATIONSHIPS

Caryomyia species have diverged in many ways. Some of their differences, particularly larval shape, are evidently adaptations for life in galls as these changed with time. Reasons for other differences are not so clear, as, e.g., why the male flagellomeres of the *C. cilidolum* species group are unlike anything seen elsewhere among *Cecidomyiini*, or how the presence of setae on the sternal and hind ventral papillae of *C. leviglobus* and *C. spiniglobus* are again expressed after having been lost, possibly before the tribe's genesis.

The genus can be divided into four groups that I informally designate here as the *striolata* (2 spp.), *cilidolum* (4 spp.), *caryae* (9 spp.), and *tubicola* (14 spp.) groups. The first is ancestral to the remainder, while the second is sister to the third and fourth. Other species are not referable to these groups because I have not to date succeeded in rearing their male sex.

The *striolata* group consists of *C. striolata* and *C. albipilosa* whose galls develop quickly in early spring instead of slowly through late spring and summer, the habit of the remaining species. Two apomorphic characters support the monophyly of these two species, the foreshortened male and female flagellomeres (Figs. 235–236) and an elongate ovipositor (as in Fig. 258). These characters evidently occurred twice in *Caryomyia*, as will be outlined in the following discussion, but this group lacks the unique developments found in the rest of the genus.

The main characters supporting the monophyly of *Caryomyia* species exclusive of the *striolata* group are the presence in the second instar of a spatula and enlarged spicules on each side of the collar segment (Fig. 273). A second instar spatula is a rare event in *Cecidomyiidae*, known elsewhere only in five other genera, all gall makers: *Paradiplosis*, a cecidomyiine genus mentioned earlier (Osgood and Gagné 1978); in at least two species of *Lophodiplosis*, a cecidomyiine genus from *Melaleuca* in Australia (Gagné, Balciunas and Burrows 1997); in two of the 11 known species of *Acacidiplosis*, also cecidomyiine, responsible for complex galls on *Acacia* in Africa (Gagné and Marohasy 1993); in *Celticecis* of the supertribe *Lasiopteridi* responsible for complex galls on *Celtis* (Moser 1965), and, again in *Lasiopteridi*, in at least one species of *Rabdophaga* (pers. obs.) responsible for galls on *Salix*. The second instar spatula appears de novo in each of these genera where, presumably, it acts as a scraper. Where this second instar spatula does occur in *Caryomyia*, a group of enlarged spicules is present on each side of the collar segment of that instar (Fig. 273). These enlarged spicules are presumably used either for scraping the internal gall surface or gaining purchase for the head. Analogous enlarged anterior spicules in the second instar are present in two other cecidomyiids known to me, *Mikiola fagi* Hartig (Dziurzyński 1961) and *Lopesia armata* Gagné (Gagné & Marohasy 1993), but instead of on the collar segment, the enlarged spicules appear on the first thoracic segment. Neither of these species has a second instar spatula.

The *cilidolum* species group, comprising *C. cilidolum*, *C. hirtidolum*, *C. tuberidolum*, and *C. viscidolum*, is distinguished by several apomorphies as follows:

1. Galls are distinguished by an apical, circular, weakened area through which pupae exit in spring (Fig. 45). All other *Caryomyia* galls have no such defined exit. The *striolata* group pupae force their way through the gall apex but the galls do not have a defined, breakaway apex, and all other *Caryomyia* species force their way through the gall side or base through a tunnel dug by the larvae the previous autumn.
2. The larval head points ventrally (Fig. 231), presumably an adaptation for the mouthparts to anchor to the feeding surface in a large spherical

- larval chamber. This character is found also in some species of the *caryae* and *tubicola* species groups that also have very large larval chambers, larger than the larvae can fill when full grown. The character is presumably separately derived where it occurs. The head capsule of gall midges usually points anteriorly (Fig. 217).
3. The spatula has a single, pointed anterior tooth (Figs. 277–280). Both the *caryae* and *tubicola* species groups also have species with a single, triangular apical tooth but those are evidently separately modified.
 4. The pupal face has a pronounced convexity just posteriad of the antennal bases and a vertical median furrow (Figs. 193–196). The *striolata* species group has a smooth face without these characteristics (Figs. 267–268).
 5. The pupal antennal bases are conspicuously elongated and dorsoventrally flattened (Figs. 193–194), unique to this group within the genus and presumably a modification for pushing open the apical gall exit.
 6. Circumfila of the male flagellomeres are reticulate and appressed (Figs. 240–241) instead of being made up of three separate circumfila with regular loops (Figs. 235–239). This is a unique development in Cecidomyiini. It is known elsewhere in *Polystepha* and *Eocincticornia* of the tribe Asphondyliini. Female circumfila also are reticulate (Fig. 241) instead of being disposed in the more usual two horizontal rings with two vertical connectives (Fig. 238). I should point out here that in the *cilidolum* group the circumfilar strands are more numerous on the venter of the flagellomeres, just as both loops and setae are usually more numerous on the venter of other cecidomyiinae. I assume that the significance of augmented circumfilar strands or setae on the ventral surface is for optimal sensory perception. When a gall midge is in flight, its antennae are normally held aloft with the venter the leading edge.
 7. The adult labella are entirely fused and asetose (Fig. 243), while in other *Caryomyia* they are partly or entirely discrete and long-setose (Figs. 242, 244).

The *caryae* and *tubicola* species groups share at least four synapomorphies, as follows:

1. The pupal face has prominent anterolateral indentations and a conspicuously produced

- frons (Figs. 188–189), presumably used during emergence from the gall in spring. In the other species groups the face is generally smooth, without lateral indentations or bumps. Non-gall making cecidomyiines have a primitively convex, smooth face. Many gall makers that pupate in their galls have various facial ridges and projections, but the particular makeup of these in *Caryomyia* is unique in Cecidomyiinae.
2. The pupal abdomen has conspicuous spines on the anterior half of the second through eighth abdominal terga (Fig. 192). These are used in exiting galls. Abdominal spines are often found in plant-feeding Cecidomyiidae that pupate in their galls, but gall makers do not universally have them.
 3. The ovipositor is longer (Fig. 258) than in the *cilidolum* group (Fig. 261), as measured by the length of the cerci that are 1/4 or less the length of the ninth segment. I consider a short ovipositor to be ancestral to a longer one; the reverse hypothesis would involve many simultaneous reversals of a complex organ, its tubes, muscles, and integument.
 4. The male hypoproct is setulose only on its posterior third (Fig. 253), an obvious reduction from the usually completely setulose cecidomyiid hypoproct.

The *tubicola* species group, which includes *C. tubicola*, *C. conoidea*, *C. deflexipili*, *C. flaticrustum*, *C. inanis*, *C. inclinata*, *C. inflata*, *C. leviglobus*, *C. marginata*, *C. recurvata*, *C. sanguinolenta*, *C. sphaerica*, *C. spiniglobus*, and *C. turbinata*, is separated from the *caryae* group by two synapomorphies. The aedeagus is notched at the apex (Fig. 247), unlike all other *Caryomyia* and other cecidomyiines known to me that have a rounded or blunt apex (Fig. 333), and the male flagellomeres are foreshortened (Figs. 237), without the distinct internodes and necks found only in the *caryae* species group (Fig. 239) and almost universally in Cecidomyiini. Assuming that foreshortened flagellomeres are derived, they evidently appeared at least twice in the genus: foreshortening appears in the basalmost *striolata* species group and again in the *tubicola* group, but here it is correlated with an apically notched aedeagus.

The *caryae* species group has, unfortunately, no synapomorphy that I can determine. The *C. caryae* group includes, besides *C. caryae*, at least *C. aggregata*, *C. hirtiglobus*, *C. persicoides*, *C. pur-*

purea, *C. shmoo*, *C. thompsoni*, *C. tuberculata*, and *C. turbanella*.

Other noteworthy characters of *Caryomyia* ostensibly appeared more than once and are not useful for grouping species or are found in single species:

1. Gall structure can be useful for defining groups, especially when supported by characters of the gall midges themselves. Some structures evidently appeared only once, as for instance the apical pupal exit in galls of the *C. cilidolum* species group (Fig. 45). Other changes, such as extraneous tissue having nothing to do with the larval chamber, appears to have come about more than once. Galls of *C. sanguinolenta* (Figs. 134–135) and *C. persicoides* (Figs. 126–129) resemble one another in general shape: both are conical, the extensive tissue surrounding the larval chamber is large-celled and soft, and the larval chamber itself is lined with a distinct pellicle that eventually hardens and presumably serves to protect the larva through the winter as the surrounding soft tissue breaks down and sloughs off. Nonetheless the galls have distinct differences: the gall of *C. sanguinolenta* has a shield-like base (Fig. 136) through which the pupa eventually emerges; that of *C. persicoides* lacks the differently textured base and its pupa emerges through the side of the gall. These differences take on more weight with the realization that adults from the two galls belong to two different species groups.
2. Larval shape reflects the space available in the larval chamber. Larvae constrained in ovoid or cylindrical chambers are ovoid or cylindrical (Figs. 215–216) and ultimately fill the available space. Larvae of some species in chambers with more space than they can fill may have a ventrally disposed head, a wide, flat body or convex segments, an elongate terminal segment, and papillae that may be situated on lobes (Figs. 226–229).
3. Verrucae and spicules that evidently serve for traction may cover all or only parts of a larva. Larvae free to crawl within a large space generally have more verrucae than larvae that are more constrained.
4. The third instar spatula is variously shaped and not predictable by gall form. One of its uses for most species of the *caryae* and *tubicola* species groups is for boring a hole through the gall wall. A one-toothed spatula (Fig. 276) is presumably derived from a two-toothed one, the ancestral form (Fig. 285), but a secondarily notched tooth (Fig. 286) may be derived from a one-toothed spatula, and a notched spatula may possibly revert to a simple, triangular tooth. Several species responsible for generally similar galls show a gradual narrowing of the two-toothed apex, and one of them has a single tooth (see under *C. flaticrustum* and cf. Figs. 287–290). The two widely spaced spatula teeth of *C. caryae* (Fig. 282) and relatives is evidently a derived state because it is unique to this genus.
5. Setation of larval papillae is uncommon in *Caryomyia* and occurs in seemingly unrelated groups of species, in either or both second and third instars. In two species, *C. leviglobus* and *C. spiniglobus*, all papillae except the terminals have setae, a unique development in Cecidomyiidae.
6. Dorsal papillae of the first through seventh larval abdominal segments are reduced to four in about half the species from the basic six found elsewhere in the genus and customarily in Cecidomyiidi. This loss does not appear to follow natural groupings in the genus, so probably happened more than once.
7. Adult antennal flagellomeres usually number 12 in the supertribe Cecidomyiidi, but may be augmented to more than the basic number, most often by an incomplete thirteenth flagellomere in one or both sexes. In *C. deflexipili* the number is augmented to 18–21. Augmentation in number of flagellomeres beyond a short thirteenth segment is rare in Cecidomyiidi, but occurs elsewhere in some species of *Planetella* (Gagné 1981).
8. Adult palpi usually have four segments (Fig. 342). Only occasionally has a specimen only three segments on one side, but this is not a specific difference. One species, *C. spherica*, which belongs to the *tubicola* species group, is unique in the genus for having only one or two palpal segments (Fig. 244). Noteworthy here is the corresponding short palpal sheath on the pupa of this species (Figs. 205–206). Interestingly, in other Cecidomyiidae that have a short palpus, e.g., in *Rhopalomyia* (Jones et al. 1983), the labella are also reduced in size and setation, but in *C. spherica* the labella are large, separate, and have exceptionally strong setae.

9. The ovipositor of *Caryomyia* ranges from generally short and pliable with short setae (Fig. 261) to somewhat longer, rigid in some species, and with a small number of long setae (262). Large, mostly separate cerci become variably reduced in size and can be almost completely joined dorsally. These modifications seem to have arisen independently within *Caryomyia*: *C. inanis* and *C. inclinata* have generally similar, rigid, completely pigmented ovipositors, but otherwise show no particular evidence of close affinity.

BIOLOGY

General life cycle.—All *Caryomyia* species are univoltine. In central Maryland adults generally emerge in late March through April from galls fallen to the ground the previous summer and fall. Later emergence evidently does not occur: adults almost never emerged from my collections after April, and second flushes of hickory leaves that replace occasional early-season damage by Lepidoptera never have *Caryomyia* galls. Within a few minutes after eclosion, adult wings and legs expand to full length and harden. Females especially are heavy-bodied and do not fly readily. In traps where they have been observed, they generally walk rather than fly when disturbed, so are easy to pick up with a dampened artist's brush. Mating in nature presumably occurs close to the emergence site. Females then fly to burgeoning hickory buds or rapidly developing leaves where they deposit eggs on the bud or leaf surface (Fig. 34).

The newly hatched larva is at first elongate-ovoid, the same shape as the egg itself. Whether the larva crawls initially, it soon settles and begins to feed, whereupon its salivary secretions induce the leaf tissue to encompass it in a gall distinctive to its species. As the gall develops, this first instar becomes flat and discoid (Fig. 35). Galls of *Caryomyia* species are essentially full-grown by the time the larva molts to the second instar. Following the molt to the second instar and an additional period of larval growth, the larva then molts to the third and last instar. Once the third instar is fully grown, in late spring for a few species or summer for the remainder, the gall either dehisces or hangs on until the leaves drop from the tree in autumn. The larva diapauses inside the gall through winter. In early spring, the larva molts to

the pupal stage and the adult develops quickly. The fully-developed adult still inside the pupal skin then forces its way through the gall epidermis, for most species through a cylindrical tunnel burrowed in the gall wall the previous autumn by the full-grown last instar. When the pupa is halfway out of the gall, the greater width of its abdomen blocks further progress through the aperture. Major sutures of the pupal head and thorax then split open, allowing the adult to emerge. Within that generalized life cycle, *Caryomyia* species show a remarkable variety of oviposition and host selection, seasonal development, gall structure, and larval and pupal adaptations. These aspects are taken up here in turn.

Oviposition and host selection.—The female selects the host and the site where the galls will subsequently develop, whether on the lamina or veins. Eggs are laid singly, in clusters, or in rows, presumably a species-specific feature. In one closely related group of four species (see under *C. cilidolium*), one species occurs only on bitternut of the *Apocarya* section, while those of the remaining three occur on the *Eucarya* section. Two of the three on the *Eucarya* section occur on the lower surface of the leaf, while one occurs exclusively on the upper surface. The top leaf surface is not a favored site for *Caryomyia* galls, with only two of the 56 species found exclusively on the top surface and a third that occurs equally regularly on either surface. Galls of about a third of the species are always found attached to veins and some of them are situated so closely together that they sometimes partly coalesce. These site selections by the female are evidently also species specific.

Seasonal development.—Galls once initiated develop quickly, but their triggering is staggered in most species. Galls of two species, *C. albipilosa* and *C. striolata*, are exceptional in that their galls appear as soon as or even before the leaves have fully unfurled in early spring. Their larvae, from first through third instar, develop within about two weeks. In central Maryland their galls normally dehisce by late May and early June. Larval development of another, more variable species, *C. urnula*, is not quite so rapid, but the galls appear soon after the two earlier species. Galls of *C. urnula* vary in time of appearance, and some galls dehisce as early as mid-June, while others remain on the leaves into September or until leaf fall. The rapid development in spring of *C. albipilosa* and *C. striolata* galls may possibly be the ancient mode

for the genus because those species share some primitive larval and adult character states of *Caryomyia*. A possible advantage of early development is that the galls are fully developed and dehisce before the hickory leaves can be affected by heavy *Phylloxera* populations that may cause leaf drop or before the leaves can be eaten by caterpillars, events I have observed for leaves bearing the more slowly developing *Caryomyia* species. Alternatively, there may be disadvantages to a gall lying on the ground through the summer. It happens that the spring galls are among the most weak-walled of *Caryomyia* galls.

The appearance of galls of the remaining species is variable. Depending on a species but also within a species, galls may become apparent only in June, July, or August. Once galls are fully grown and first instars have molted, larval development progresses fairly slowly through most of the summer. Galls may dehisce from the leaves beginning in August but galls of some species remain on the leaves until frost or even after leaf fall.

Gall structure.—All *Caryomyia* species induce complex galls on hickory leaflets. A complex gall is the result of reorganized tissue that is different from any structure normally found on the host plant. Most of the great diversity of galls caused by *Caryomyia* spp. (Figs. 36–164), including color, shape, relative hairiness, and in some a sticky coating and/or false chamber, occurs outside the bounds of the larval chamber and has no apparent effect on the larva, at least during feeding. Examples of benign structures would be the knob at the apex of the *C. leviglobus* gall (Fig. 62) or the recurved apex of the *C. recurvata* gall (Fig. 90). I observed no sign of any insect, including eggs of parasitoids, in any partial or complete false chamber, so a false chamber does not appear to be a protective adaptation in the same manner as it is for galls of Cynipidae (Csóka et al. 2005). Whether relative stickiness, hairiness, or hardness deter some parasitoids from laying their eggs and have some significance for gall diversity is a determination that must await further study, but one explanation for gall diversity might be that the differences are only fortuitous and trivial accidents due to genetic drift during repeated isolation events over time.

Larval adaptations.—Larvae of *Caryomyia* are less homogeneous than adults. Adults need to steer their way out of the galls while still encompassed by the pupal skin, emerge from the pupal skin, then harden, and then mate, and the females

have to lay their eggs at a particular site on a suitable substrate. In contrast, the varied needs of the larvae, in part determined by the shape of the larval chamber in the gall, gall intrusions, and relative thickness and hardness of the wall through which larvae need to burrow, have led to some remarkable anatomical adaptations variously distributed among *Caryomyia* spp. Depending on the species, larvae are either sessile or active while still growing. Larvae of *C. tubicola* and *C. sanguinolenta*, e.g., fill the width or entire larval chamber, at least by the time they are full-grown. Their larvae are evenly cylindrical or ovoid, respectively, and have a modicum of horizontal rows of raised verrucae or denticles to effect crawling or other movement. Larvae of species that live in large, roomy chambers, e.g., *C. ciliolium* and *C. caryae*, are more or less dorsoventrally flattened, have expanded lateral and terminal extremities, and are variously haired or lobed for better traction. In addition, their bodies are completely covered with a rough integument and the head capsules of some of those species are oriented ventrally instead of anteriorly. In a freshly cut gall with a spherical larval chamber, one can see that the ventral side of the larva is closely appressed and curved along the interior surface of the large chamber.

The third instar spatula shows some variety of size and shape, which seems partly associated with gall form. Before entering diapause in summer or fall the third instar uses its spatula to cut a cylindrical tunnel on the side or near the bottom of the galls, up to but not including the outer epidermis. The pupal-encased adult will emerge through this tunnel or weakened area the following spring. Conspicuous wear of the spatula itself through the effects of such abrasion can be seen on third instar exuviae sloughed off after pupation.

A particularly striking adaptation within *Caryomyia* is the development of a spatula on all *Caryomyia* second instars, except in *C. albipilosa* and *C. striolata*, the two spring gallmakers discussed earlier. A spatula is always present in third instar cecidomyiids except in the few species or genera that have secondarily lost it. Its appearance in second instars is rare, found only in gall makers, and presumably separately derived in the few genera where it occurs (see under Intrageneric Morphology and Relationships). This structure is presumably employed as a scraper to encourage growth of food-producing cells in the galls. A trait associated with this development in *Caryomyia* is the

presence of an enlarged group of spicules on each side of the collar segment behind the head (Fig. 273). The enlarged spicules presumably also aid as a scraper or anchor for the head capsule against the internal gall wall surface.

Pupal adaptations.—Adaptive structures include the different shapes and disposition of antennal bases, facial protuberances, and rows of abdominal spines on most species. These structures are presumably used in exiting from the harder galls because they are undeveloped in *C. albipilosa* and *C. striolata*, the two species that make softer, thin-walled galls, and in *C. urnula* and the *C. ciliolium* group that escape their galls through an apical trap door.

HOST-SPECIFICITY

The host range of individual *Caryomyia* species is mostly hickory section specific rather than species specific, and some species may occur on both sections of hickories (Table 2). Fifty-three of the 56 species feed on *Eucarya*, and there is no evidence to show that they discriminate among the species of the section. Hickories themselves commonly hybridize in nature (Grauke 1988, 2003), which may indicate a lack of barriers for *Caryomyia* spp. Further, species of other genera on hickories, *Caryadiplosis* spp., *Contarinia cucumata*, and *Gliaspilota glutinosa* (q.v. this paper), are regularly found on various species of *Eucarya* as well as of *Apocarya*. Of the 53 *Caryomyia* species that feed on *Eucarya*, one is commonly, two occasionally, and three rarely found also on *Apocarya*. Galls of *Caryomyia tubicola*, the species most commonly found on both sections, appear on different tissues from one section to another. On *Eucarya* galls are most often found on the leaf lamina, but on bitternut they are usually situated adjacent to leaf veins. Possibly the open lamina of bitternut leaves cannot always sustain the galls because its leaves seem generally not as thick and stiff as those of the *Eucarya* group.

Only three species of *Caryomyia*, *C. ansericolum*, *C. ciliolium*, and *C. spinulosa*, are restricted to bitternut of the *Apocarya* section. They possibly occur also on that section's other species, but those trees were not sampled as often during this study as was bitternut. Nevertheless, I only once found a *Caryomyia* gall on either of two other species of the *Apocarya* section, pecan and water hickory, and neither one of the collections was of

the species restricted to bitternut. Interestingly, the three species found only on bitternut each appear more closely related to species on *Eucarya* than to one another, so colonization from one to the other section evidently happened at least three times.

DISTRIBUTION

Many genera of gall midges restricted to particular host genera occur naturally across the entire breadth of the Holarctic Region. Examples include *Semudobia* on birches (Roskam 1977), *Cecidomyia* on pines (Gagné 1978), and *Macrodiplosis* (spring galls) and *Polystepha* (summer galls) on oaks (Gagné 1989, q.v. for other examples). These associations presumably antedate the separation between Europe and North America in the mid-Eocene. As mentioned earlier, hickories, while now much more restricted in distribution than are birches, pines, or oaks, once ranged across the Holarctic before being extinguished in Europe and elsewhere during the Pleistocene (Manchester 1987). It is probable that *Caryomyia*, too, once also ranged across the Holarctic so that whatever influences shaped the distribution of hickories during geological time presumably also affected *Caryomyia*.

Most *Caryomyia* species occur throughout the range of hickories in eastern North America. Some, such as *C. caryae*, *C. thompsoni*, and *C. tubicola*, can be anticipated on almost any tree of the *Eucarya* section, while others, e.g., *C. cynipsea* and *C. glebosa*, although geographically widespread, are rare. A separate phenomenon is individual tree susceptibility. Trees of the *Eucarya* section may annually have large populations of galls of many species while adjacent trees of the same species may have almost none. Over a period of several years 26 species of *Caryomyia* were found on one open-grown pignut in the National Arboretum in Washington, DC. while its near neighbor, a pignut of similar age, size, and situation, never bore but a few individuals of only one species. A mockernut at another site in the National Arboretum sustains each year a large population of *C. tubicola* galls so heavy that the leaflets droop, but bears few other kinds.

Even some of the more common galls can have a patchy distribution. A case in point is the great difference only 75 miles apart at two of the sites where I collected hickory galls for over 10 years.

Table 2. List of gall midges (excl. of *Lestodiplosis* spp. and *Dasineura* sp.) on hickories, their scientific and common names. Presence on *Eucarya* and/or *Apocarya* sections is indicated by an asterisk.

Scientific Name	Common Name of Gall	on Eucarya	on Apocarya
<i>Caryadiplosis biconvexa</i> Gagné	hickory convex leaf swelling	*	*
<i>Caryadiplosis venicola</i> Gagné	hickory midrib swelling	*	*
<i>Caryomyia aggregata</i> Gagné	hickory aggregate gall	*	
<i>Caryomyia albipilosa</i> Gagné	hickory white-haired gall	*	*
<i>Caryomyia ansericollum</i> Gagné	hickory gooseneck gall		*
<i>Caryomyia arcuata</i> Gagné	hickory sombrero gall	*	
<i>Caryomyia asteris</i> Gagné	hickory starburst gall	*	
<i>Caryomyia antennata</i> Felt	hickory spindle gall	*	
<i>Caryomyia biretta</i> Gagné	hickory beret gall	*	
<i>Caryomyia caminata</i> Gagné	hickory chimney gall	*	
<i>Caryomyia caryae</i> (O.S.)	hickory sticky globe gall	*	
<i>Caryomyia caryaecola</i> (O.S.)	hickory onion gall	*	
<i>Caryomyia cilidolum</i> Gagné	hickory fuzzy ginger jar gall		*
<i>Caryomyia conoidea</i> Gagné	hickory fuzzy gumdrop gall	*	
<i>Caryomyia cucurbitata</i> Gagné	hickory pumpkin gall	*	
<i>Caryomyia cynipsea</i> (O.S.)	hickory smooth woody gall	*	
<i>Caryomyia deflexipili</i> Gagné	hickory reflexed hair gall	*	
<i>Caryomyia echinata</i> Gagné	hickory spiny gall	*	
<i>Caryomyia eumaris</i> Gagné	hickory Persian shoe gall	*	
<i>Caryomyia flaticrustum</i> Gagné	hickory puff tart gall	*	
<i>Caryomyia glauciglobus</i> Gagné	hickory blue-powder gall	*	
<i>Caryomyia glebosa</i> Gagné	hickory knobby cone gall	*	
<i>Caryomyia guttata</i> Gagné	hickory teardrop gall	*	
<i>Caryomyia hirtidolum</i> Gagné	hickory hairy ginger jar gall	*	
<i>Caryomyia hirtiglobus</i> Gagné	hickory woody globe gall	*	
<i>Caryomyia holotricha</i> (O.S.)	hickory hairy gumdrop gall	*	
<i>Caryomyia inanis</i> Felt	hickory papery gall	*	
<i>Caryomyia inclinata</i> Gagné	hickory inclined gall	*	
<i>Caryomyia inflata</i> Gagné	hickory rubbery gall	*	
<i>Caryomyia lenta</i> Gagné	hickory popover gall	*	
<i>Caryomyia levicrustum</i> Gagné	hickory plain tart gall	*	
<i>Caryomyia leviglobus</i> Gagné	hickory smooth ball gall	*	
<i>Caryomyia marginata</i> Gagné	hickory marginate gall	*	
<i>Caryomyia melicrustum</i> Gagné	hickory honey tart gall	*	
<i>Caryomyia ovalis</i> Gagné	hickory ovoid gall	*	
<i>Caryomyia persicooides</i> (O.S.)	hickory peach-haired gall	*	
<i>Caryomyia procumbens</i> Gagné	hickory hairy squash gall	*	*
<i>Caryomyia purpurea</i> Gagné	hickory purple gumdrop gall	*	
<i>Caryomyia recurvata</i> Gagné	hickory smooth squash gall	*	
<i>Caryomyia sanguinolenta</i> (O.S.)	hickory smooth gumdrop gall	*	
<i>Caryomyia shmoo</i> Gagné	hickory shmoo gall	*	
<i>Caryomyia spherica</i> Gagné	hickory spherical woody gall	*	
<i>Caryomyia spiniglobus</i> Gagné	hickory spiny ball gall	*	
<i>Caryomyia spinulosa</i> Gagné	hickory thorn gall		*
<i>Caryomyiastellata</i> Gagné	hickory starry-base gall	*	
<i>Caryomyia striolacrustum</i> Gagné	hickory striate tart gall	*	
<i>Caryomyia striolata</i> Gagné	hickory fluted cone gall	*	*
<i>Caryomyia subulata</i> Gagné	hickory awl-shaped gall	*	
<i>Caryomyia supina</i> Gagné	hickory supine squash gall	*	
<i>Caryomyia thompsoni</i> Felt	hickory placenta gall	*	
<i>Caryomyia tuberculata</i> Gagné	hickory bumpy woody gall	*	

(continued)

Table 2. List of gall midges (excl. of *Lestodiplosis* spp. and *Dasineura* sp.) on hickories, their scientific and common names. Presence on *Eucarya* and/or *Apocarya* sections is indicated by an asterisk. (continued)

Scientific Name	Common Name of Gall	on Eucarya	on Apocarya
<i>Caryomyia tuberidolium</i> Gagné	hickory bumpy ginger jar gall	*	
<i>Caryomyia tubicola</i> (O.S.)	hickory bullet gall	*	*
<i>Caryomyia tumida</i> Gagné	hickory frosted gall	*	
<i>Caryomyia turbanella</i> Gagné	hickory turban gall	*	
<i>Caryomyia turbinata</i> Gagné	hickory top-shaped gall	*	
<i>Caryomyia urnula</i> Gagné	hickory urn gall	*	*
<i>Caryomyia viscidolum</i> Gagné	hickory sticky ginger jar gall	*	
<i>Contarinia bulliformis</i> Gagné	hickory leaf bubble		*
<i>Contarinia cucumata</i> Gagné	hickory cucumber gall	*	
<i>Gliaspilota glutinosa</i> (O.S.)	hickory sticky leaf spot	*	*
<i>Harmandiola nucicola</i> (O.S.)	hickory husk swelling	*	
<i>Parallelodiplosis caryaefeltii</i> Felt	an inquiline	*	*

The two sites are the National Arboretum in Washington, DC and a private property on Cherry Run, 6 mi NW of Hedgesville, WV, both sites close to the Potomac River. These sites share 18 species. The Arboretum has 11 species not known from the Cherry Run property, while the latter site has 13 not found at the Arboretum. Even two sites separated by only 10 miles, the Arboretum and the Beltsville Agricultural Research Center show some differences. These two sites have 26 species in common, but the Arboretum has one not found at Beltsville, while Beltsville has five not found at the Arboretum.

Besides local differences in occurrence, 11 species are so far unknown east of the Appalachians in the mid-Atlantic Region. These are: *C. asteris*, *C. biretta*, *C. deflexipili*, *C. echinata*, *C. inanis*, *C. inclinata*, *C. inflata*, *C. lenta*, *C. marginata*, *C. procumbens*, and *C. subulata*. One other species, *C. arcuata*, has a similar distribution except that it has also been found near the South Carolina coast. This distribution is fairly definite (Map 2); if these species occurred along the Piedmont of Virginia and Maryland, where I collected widely and often over 13 years, I should have collected them. This pattern is surprising inasmuch as only fairly low mountains separate the Piedmont from eastern West Virginia where those "western" *Caryomyia* species can be found. Interesting also is that most of these 12 species occur to the north into New England. Possibly they occurred long ago on the Piedmont but were extirpated as the forests of the Piedmont were largely cut for farmland early in this country's history. Still, with regrowth of

forests, prevailing winds should by now have wafted females in an easterly direction, or the species should have spread via watercourses that cut through the mountains and run through the mid-Atlantic region. Nor do these *Caryomyia* species appear to be particularly affected by altitude or temperature, inasmuch as several occur from Mississippi and Arkansas to New England.

In addition to that continental distribution pattern are two examples of local species paucity. The first is on scrub hickory, a low-growing tree of sand dunes and sandy ridges of central Florida and the sole species of *Eucarya* growing there. It is host to only four *Caryomyia* species, three of them widespread, but the fourth, *C. guttata*, an endemic, is the only *Caryomyia* so limited in distribution. Galls from scrub hickory were collected over several seasons by K. Hibbard and one year at several sites also by me. As a comparison, only about 150 miles north of those collections on scrub hickory, in Gainesville, Florida, where two species of the *Eucarya* section, mockernut and pignut, grow together, I found 15 species of *Caryomyia* in a two-hour search.

The other example of a locally restricted number of species is on Mexican hickory in eastern Mexico. On one isolated population of this tree, only about 12 sq. mi. in extent in a cloud forest of the Sierra Madre Oriental southwest of Ciudad Victoria, Tamaulipas, I observed galls of only two species, *C. caryaefeltii* and *C. inclinata*, in about equal numbers during several days' search. Galls of *C. caryaefeltii* there belong to one of the two regular forms, the more robust type of that species; those of *C. in-*

clinata, a highly variable species even in the United States, mostly show a greatly expanded base for that species. This population of a *Eucarya* hickory is separated by about 550 miles from the next closest United States hickories, north of Houston, Texas. Near New Waverly, Texas, about 35 miles north of Houston, I collected from black and mockernut hickories 30 species of *Caryomyia*, including *C. caryaiae* and *C. inclinata* in about three hours. Assuming that the Mexican population of hickories was once conterminous with the Texas population, possibly as long ago as before the Pleistocene (Graham 1999), galls of the two species of *Caryomyia* in Mexico would seem not to have changed at all during that long period of time. The two *Caryomyia* species that occur on Mexican hickory are possibly all that remain of a more diverse assemblage of species that became extinct over time.

Those two examples of a reduced number of species at isolated sites have in common the availability of only one host in a restricted area. Possibly two host species growing together preserve more variability in *Caryomyia* spp. than only one restricted host. This seems to hold true for other insects on other hosts: the more widely distributed willow species tend to support more gall-making sawflies (Hymenoptera: Tenthredinidae) (Roininen et al. 2005) and the numerous species of oaks in the cloud forests of Costa Rica support many species of gall wasps (Hymenoptera: Cynipidae) while the one oak species in the lowland forest supports only two (Hanson & Gómez-Laurito 2005). Geographical restriction over long periods of time must also be a factor in the loss of species. The complete lack of gall midges on beeches in North America may be an example of this. Unlike birches, pines, and oaks mentioned earlier that together with their particular cecidomyiids are distributed across the Holarctic Region, American beeches are devoid of cecidomyiids in contrast to European and Asian beeches that are hosts to three cecidomyiid genera comprising many species (Buhr 1964 & 1965, Tsuda 1982, Sato & Yukawa 2001, Yukawa & Masuda 1996). Gall midges of beech possibly also once occurred in the Nearctic but became extinct through a bottleneck effect as the range of beeches became severely constricted during successive Pleistocene glaciations.

In *Caryomyia*, speciation seems best explained by geographic isolation. Glacial phases comprised about 90% of the Pleistocene age, time when deciduous tree species survived in small popula-

tions (Davis 1983). The probability of extinction for individual species was affected by factors such as climate severity, extent of geographical displacement of particular species, the size of populations, and the community composition of the forest in refuge areas (Davis 1983). While most extant species of *Caryomyia* are widely distributed, some are more common than others, and some species are able to live on trees in both sections of *Carya*. A species of *Caryomyia*, e.g., *C. tubicola*, that presently has a widespread distribution (Map 1) and does not discriminate between hickory sections, would appear to have a better chance to survive an ice age than would rarer species. Conversely, as the range of hickories became constricted and fragmented, those rare or more local species of *Caryomyia* now known from only two or three localities might be more likely extinguished. In addition, if these rare species did not already exist in what was to become a refuge during an ice age, their chances for survival would be further diminished. In sum, survival during Pleistocene glaciations would favor those species already in the areas that became refugia, which would likely be the commonest and most widely disseminated species, and the rarer species would be the most likely to be lost. Once isolated during a glacial period, various aspects of a species's variability might be selected and the process of speciation begun. Subsequent gradual dispersal north and restored sympatry of all the species throughout eastern North America during the interglacials might then serve to discontinue the process of speciation until the next glacial period.

MORTALITY FACTORS

Caryomyia populations are greatly affected by parasitoids and predators, but also by less definite causes. Galls cut open in spring after adults should have emerged often revealed first instars, sometimes also second instars, that died the previous year. The galls were otherwise clean, with no sign of fungus or parasitoids. Possibly death in these cases was due to weather or plant resistance, and two examples I know of indicate that weather is a factor. At a regular collecting site in West Virginia one year, a late frost on May 10 killed the early flush of leaves of many hickories on which galls were already evident. On another occasion, in late summer in Sallisaw, Oklahoma, when larvae should have been in the third instar, I col-

lected from a grove of trees hundreds of stunted *C. caryaecola* galls, all only half-grown and each containing a dead first instar. These were evidently killed at the same time and by the same cause earlier in the season. Interestingly, galls of this species of *Caryomyia* were the only stunted ones I found at that site.

Dissection of galls showing no pupal or parasitic hymenopteran exit holes in spring often showed that larvae were killed or eaten by fungi or mites over the winter. My method of rearing, with 100 or so galls in a small pot, may attract a greater concentration of predators than do galls in a more natural situation. From my rearing pots, I occasionally reared *Bradysia coprophila* (Lintner) (Diptera: Sciaridae) in large numbers. I observed several times that sciarid larvae, possibly of that species, had broken through the epidermis at the end of exit tunnels and were actively feeding on larvae or pupae inside. In one case three sciarid larvae were inside a gall, wound around and inside a *Caryomyia* pupa that they had almost completely consumed. In another, a sciarid had broken through the base of a gall and was feeding on a larva. Predaceous mites could occasionally be seen in the pots, and I once observed a male *Caryomyia* being attacked by mites as it was emerging.

Hymenopterous endo- and ectoparasitoids were often seen when freshly collected galls were cut open to extract *Caryomyia* larvae or determine their progress. Many parasitoids emerged from galls in spring, and representatives are now kept in the Hymenoptera section of the National Collection of Insects. Most common were Platygastridae, some not yet identified that were reared from *C. caryaecola*, *C. flaticrustum*, *C. inclinata*, *C. leviglobus*, *C. melicrustum*, *C. persicooides*, *C. procumbens*, *C. purpurea*, *C. thompsoni*, *C. tuberculata*, and *C. tubicola*, and others belonging to *Eritrissonerus* n. sp. near *cecidomyiae* Ashmead that were reared from *C. ansericollum*, *C. aggregata*, *C. cilidolum*, *C. deflexipili*, *C. eumaris*, *C. glauciglobus*, *C. hirtidolum*, *C. persicooides*, *C. sanguinolenta*, *C. spinulosa*, *C. thompsoni*, and *C. tuberculata*. Other less commonly reared parasitoids were: an unidentified species of *Gastriancistus* (Pteromalidae) from: *C. ansericollum*, *C. flaticrustum*, *C. guttata*, *C. holotricha*, *C. inclinata*, *C. leviglobus*, *C. persicooides*, *C. purpurea*, *C. sanguinolenta*, *C. thompsoni*, *C. tuberculata*, and *C. tubicola*; a pirenine pteromalid from *C. aggregata*, *C. ansericollum*, *C. caryaecola*, *C. holotricha*, *C. purpurea*, and *C. tuberculata*; and a possible new species of *Torymoides* (Torymidae) from *C. aggregata*, *C. flaticrustum*, and

C. glauciglobus. Additionally, three species of parasitoids from *Caryomyia* are known from the literature (Krombein et al. 1979): a torymid, *Torymus durus* (Osten Sacken) reared from *C. caryaecola*, and two platygastrids, *Platygaster caryaecola* Ashmead, reportedly reared from *C. holotricha*, and *Platygaster hyalinipennis* (Ashmead), reportedly reared from *C. tubicola*.

As mentioned earlier, predaceous cecidomyiids, *Lestodiplosis* spp., were occasionally found in galls or reared from galls in spring. In addition, an inquiline gall midge, *Parallelodiplosis caryaecola* (Felt), treated separately in this paper, was occasionally found in or around galls. Its impact and precise effect in galls of *Caryomyia* spp. is not known.

SPECIES TREATMENTS

Caryomyia aggregata Gagné, new species

Description.—*Gall* (Figs. 21a-b, 156–157): Common, on most *Eucarya* hickories; on lower leaf surface on vein, usually clustered in a row along major vein and often in such close aggregation as to partially coalesce; 3.0–5.0 mm in height, spheroid to bilaterally compressed, sometimes pointed at apex, when coalesced bearing two or more larval chambers in an apparently single gall; covered with thick, mostly brown hair obscuring gall surface; base with small, irregular, shallow, central to off-center excavation; wall woody, thick, especially above, larval chamber irregularly ovoid, glabrous, green to brown. The gall of this species can be confused with several other spheroid-conical, densely hairy galls, but its position along the major veins and usual crowding sets it apart from galls of the other species, e.g., *C. holotricha* and *C. purpurea*. Galls were described in Osten Sacken (1862) as a variant of typical galls of *C. holotricha*, but galls of the latter always have an apical intrusion of hairs in the larval chamber and occur between instead of on the veins.

Adult: **Head:** Antenna with 12 flagellomeres; male flagellomeres binodal with definite internode and neck, circumfila with short loops, their bases widely separated (as in Fig. 239); female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella (as in Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4 segmented. **Thorax:** Wing length 3.1–3.6 mm in male (n=5), 3.9 mm in female (n=5). **Male abdomen:** Third through eighth tergites each with continuous sin-

gle row of posterior setae, those of eighth as strong as on preceding tergite. Genitalia (Fig. 186): hypoproct nearly parallel sided, concave posteromesally, the margin partly setose, but not in concavity, dorsum setulose only on distal third; apex of aedeagus convex; gonostylus broad at apex. **Female abdomen:** Third through eighth tergites each with mostly single, continuous row of posterior setae, the eighth with double continuous or mesally broken row of setae weaker than those of preceding tergite. Ninth segment pliable except for slender dorsal sclerite, setae long but sparse. Cerci elongate-ovoid, pointed apically, pigmented, fused dorsally on basal third.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, moderately separated, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 2.2–3.2 mm (n=10). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 323) with single tooth tapering from wide base to pointed apex and elongate, wide shaft. Papillae without setae. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with dorsum almost completely covered with verrucae, and venter spiculose anterior to sternal papillae and on posterior third. Terminal segment shorter than eighth. **Second instar:** Length 1.0–1.3 mm (n=4). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, papillae setose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, left-most of 5 larvae on slide mount, from gall on *C. tomentosa*, Beltsville, Maryland, IX-28-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *aggregata* is a Latin adjective meaning clustered, with reference to the typically closely juxtaposed galls of this species.

Affinities.—The closest relative of this species among the *C. caryae* species group is not apparent. Galls of this species and those of *C. guttata* are the only ones known to grow so closely together, coalescing at times.

Biological notes.—Small, tan, white haired galls in tight or loose rows along midrib were

found with first instars in central Maryland on May 26. In mid-June galls were full-sized with second instars. In mid-July, third instars could be found but until mid-August most galls contained second instars. By late August all galls contained third instars.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*). **ARKANSAS:** 2 mi S DeQueen (*tomentosa*); Osage (*texana*); Piney (*texana*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Litchfield (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*). **FLORIDA:** Gainesville (*tomentosa*); Lake City (*tomentosa*). **GEORGIA:** Forsyth (*glabra*, *ovata*, *tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson Lake St. Pk., Carter Co. (*glabra*, *tomentosa*); Winchester (*laciniosa*). **ILLINOIS:** Marshall (*tomentosa*). **INDIANA:** Spencer Co. (*tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Calverton (*tomentosa*); Clarksburg (*tomentosa*); College Park (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*glabra*, *tomentosa*); Potomac (*tomentosa*); Ridgely (*tomentosa*); Silver Spring (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra*, *tomentosa*). **MASSACHUSETTS:** Leominster (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); vic. Worcester (*Carya* sp., photographed in Thompson 1915: 92, Fig. 242); Wrentham (*ovata*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 193, Choctaw Co. (*tomentosa*). **MISSOURI:** Crowley Ridge Roadside Pk, Stoddard Co. (*glabra*, *tomentosa*); Holly Ridge State For., Stoddard Co. (*glabra*, *tomentosa*); Rolla (*texana*); Wildwood (*tomentosa*). **NEW HAMPSHIRE:** Greenland (*ovata*); Kingston (*ovata*). **NEW YORK:** Herkimer (*ovata*); Hyde Park (*ovata*); Ithaca (*ovata*); Ravenna (*ovata*); Shokan (*tomentosa*). **NORTH CAROLINA:** Alberta (*glabra*); Dertches (*glabra*, *tomentosa*); Providence (*tomentosa*). **OHIO:** Hocking St. For., Hocking Co. (*ovata*); Hocking Co. (*Carya* spp., Wells 1916: Figs. 21a–b). **PENNSYLVANIA:** Pavia (*ovata*); Schellsburg (*ovata*). **TENNESSEE:** Dandridge (*tomentosa*). **VIRGINIA:** Carson (*tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra*, *tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** 6 mi NW Hedgesville (*ovata*).

Specimens of *C. aggregata* examined.—**ARKANSAS:** Osage, IX-9-2004 (larvae). **CONNECTICUT:** Amston, IX-17-1999 (larvae). **INDIANA:** Spencer Co., IX-20-1995 (larvae). **KENTUCKY:** Brownsville, IX-21-1995 (larvae); Winchester, IX-22-1995 (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, X-13-1999, IX-

28–1999 & VI-22–2004 (larvae), X-24–2005 (larvae); 28 ♂, 1 ♀, pupae, em. III-30 to IV-7–2006); Gaithersburg, X-4–1994 (larvae); Ridgely, IX-2003 (4 ♂, 2 ♀, pupae, em. IV-2004); Silver Spring, X-24–1999 (larvae). MASSACHUSETTS: Leominster, IX-21–1994 (larvae); Petersham, IX-6–2000 (♀, em. IV-2001); vic. Worcester, M.T. Thompson (2 ♂, 2 ♀); Wrentham, IX-20–1994 (larvae). MISSOURI: Wildwood, IX-8–2004 (larvae). OHIO: Hocking St. For., Hocking Co., IX-19–1995 (larvae). WASHINGTON, DC: National Arboretum, IX-30–1999 (larvae; 3 ♂, 3 ♀, pupae, em. IV-2000), X-3–1994 & VII-13–2000 (larvae); Walter Reed Army Medical Center, X-1999 (larvae; ♀, em. IV-2000) and X-2004 (3 ♀, em. IV-1–2005). WEST VIRGINIA: 6 mi NW Hedgesville, VIII-27–2000 (larvae).

Caryomyia albipilosa Gagné, new species

Description.—*Gall* (Figs. 39–40): Common, a spring gall, on both *Apocarya* and *Eucarya* hickories; found singly or in groups on lower leaf surface between veins; 3.5–5.0 mm in height, elongate-conical, narrowing gradually from base to pointed apex; surface whitish green, eventually turning brown, obscured except at apex by white hairs longer than gall diameter; gall base shallowly concave; wall uniformly thin, becoming brittle; larval chamber rough with weak longitudinal ridges. This gall differs from that of *C. striolata* only in having a thick covering of long, white hair.

Adult: **Head:** Antenna with 12 flagellomeres and usually a short 13th without circumfila in male; each of the regular 12 male flagellomeres (Fig. 235) scarcely binodal, basal flagellomeres only slightly narrowed beyond basal circumfilum, less constricted on more distal flagellomeres, loops of circumfila short, subequal in length; female flagellomeres (Fig. 236) with 2 horizontal circumfila connected by 2 vertical strands. **Thorax:** Wing length 1.7–2.0 mm in male (n=5); 1.9–2.2 mm in female (n=4). **Male abdomen:** Third through sixth tergites each with posterior setae continuous across width, in mostly single row; seventh tergite with only a few posterolateral setae; eighth tergite more weakly sclerotized, with anterior pair of trichoid sensilla the only vestiture. Genitalia (Figs. 249–250): hypoproct broadest posteriorly, weakly concave posteromedially, posterior margin setose, dorsal surface extensively setulose; aedeagus narrowing from base to apex, rounded at apex. **Female abdomen:** Third through seventh tergites

each with posterior setae continuous across width, in mostly single row; eighth tergite more weakly sclerotized than preceding tergite, with sparse posterior row of setae, the setae not as long as on seventh tergite. Ninth segment (Fig. 260) pliable except for slender dorsal sclerite, setae shorter than cerci, in two groups, one dorsolateral, one ventral. Cerci elongate-ovoid in lateral view, fused dorsally on basal third.

Pupa (Figs. 267–268): Antennal bases parallel in ventral view, carinate anteroventrally, the mesal corner elongated, terminating anteriorly in short, obtuse projection. Face without incisions, frons and clypeus not protruding. Abdominal tergal spinules all similarly minute.

Larva: Third instar: Length 1.8–2.1 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 275) with 2 separate, equilateral teeth anteriorly, the intervening space with 1–4 denticles. Two, occasionally 3, lateral papillae on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Papillae without setae, their bases not raised. Abdominal segments dorsally lined, subverrucose, with sparse, pointed spicules mainly surrounding the 2 lateral pairs of dorsal papillae, and ventrally with spicules anterior to sternal papillae. Terminal segment as long as eighth. **Second instar:** Length 0.7–1.1 mm (n=10). Collar segment without enlarged spicules laterally. Without spatula. Bases of dorsal and pleural papillae slightly raised, asetose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. tomentosa*, Entomology Road, Beltsville, Maryland, V-29–1994, R.J. Gagné.

Etymology.—The name *albipilosa* is an adjective from the Latin meaning white haired and refers to the gall's thick covering of white hair.

Affinities.—Except for the presence of white hair covering the gall, I can detect no difference between this species and that of *C. striolata*. These are the only strictly spring-occurring galls in this genus and differ in several other important ways from their congeners: the second instar lacks both a sternal spatula and a group of enlarged spicules on each side of the collar segment; the third instar has a clove-like spatula most like that of the majority of Cecidomyiini. The absence in the second instar of a spatula and of enlarged prothoracic papillae place this species and *C. striolata* as the sister group of the remaining *Caryomyia*. That the

galls of these two species appear in spring and dehisce soon after further separates them from remaining *Caryomyia* spp.

Biological notes.—In central Maryland this species is one of two spring galls with larvae developing between late April and early June. A series of adults emerged from caged previous year's galls on 16–18 April when hickory leaves were unfurling. A specimen of *Lestodiplosis*, a predaceous cecidomyiid, was reared with this series of adults. Very small, unidentifiable galls were evident on May 17, 2005. Circled with a marker, these traces were full-grown galls of *C. albipilosa* with full-grown larvae on May 24. Galls still on the leaves after mid-June are parasitized or contain dead larvae. See under *C. striolata* for more details on timing of galls.

Collections of galls.—Galls of this species are presumably more common than this short list indicates, but most of my collections outside of the Washington area were made in summer, when galls with live, fully developed larvae would already have fallen from the leaves. **CONNECTICUT:** Meriden (*tomentosa*); Southbury (*glabra*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Silver Spring (*tomentosa*); Wheaton (*tomentosa*). **NEW YORK:** Addison (*glabra*). **VIRGINIA:** Carson (*tomentosa*); Leesburg (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra*). **WEST VIRGINIA:** Falling Waters (*cordiformis*)

Specimens of *C. albipilosa* examined.—**MARYLAND:** Beltsville, USDA Agricultural Research Center, VI-2-1993 (larvae; 7 ♂, 4 ♀, pupae, em. IV-17 to 19-1994), V-30-1993, V-29-1994, V-4-1997, and V-16 to 19-2000 (larvae); Gaithersburg, V-23-2000 (larvae); Silver Spring, V-21-1994 (larvae); Wheaton, V-21-1994 (larvae).

Caryomyia ansericollum Gagné, new name

Caryomyia caryaecola Felt 1921: 114. Junior secondary homonym of *Cecidomyia caryaecola* Osten Sacken; Gagné 2004: 100, as new junior synonym of *Caryomyia caryaecola* (Osten Sacken) to avoid coining new name for *C. caryaecola* (Felt).

Description.—**Gall** (Figs. 147–148): Infrequent, known only from bitternut of the *Apocarya* section; usually in closely set series, attached to vein on lower leaf surface, occasionally so recurved as to break through leaf surface to upper surface;

4.1–9.0 mm in height, upright, leaning, or recurved, base spheroidal, abruptly narrowed to elongate, narrow, curved or sinuous neck, the apex digitate; with short to long, crinkled, white to light brown hair not obscuring gall surface; green, turning brown, not sticky; base with irregular, shallow, central depression; larval chamber basal, ovoid, white, surrounded by thick, green tissue turning brown and woody; a bundle of fibers present between larval chamber and gall apex. This is the only gall on bitternut with thick, woody tissue; the others are thin-walled and brittle.

Adult (female only): Head: Antenna with 12 flagellomeres, flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4 segmented. **Thorax:** Wing length 3.3–3.5 mm (n=3). **Abdomen:** Third through seventh tergites each with continuous mostly double posterior row of setae, thinning to single row mesally, eighth tergite with single row of posterior setae. Ninth segment (Fig. 263) pliable except for slender dorsal sclerite, setae long but sparse. Cerci elongate-ovoid, pointed apically, pigmented, fused dorsally on basal third.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 2.2–3.2 mm (n=10). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 319) with tapering, acutely-pointed tooth and elongate shaft, wide anteriorly, narrowing beyond. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae present on first 7 abdominal segments. Abdominal segments with verrucae extensively covering dorsum and rows of small, pointed spicules covering venter except at mid-length. Terminal segment shorter than eighth. **Second instar:** Length 1.0–1.1 mm (n=3). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider shaft, narrowing gradually posteriorly. Bases of dorsal and pleural papillae slightly raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Lectotype* of *Caryomyia caryaecola*, here designated, third instar, a1786, ex *Carya cordiformis*, Hamburg, New York, X-17-1907, in Felt Collection, New York State Museum. *Paralectotypes* as follows: galls of *C. ansericollum*, Felt 1915d, Pl. 4, Fig. 9 (colored drawing by L.H. Joutel); galls of *C. spinulosa* on *Carya cordiformis*, Felt 1921, Pl. 10, Fig. 2 (photo); galls of *Carya stellata* on *Carya* sp., Felt 1921, Pl. 10, Fig. 3 (photo), (ex Stebbins 1910: Fig. 13). No paralectotype galls remain in the Felt Collection; they exist only as published drawings and photographs.

Felt (1921) redescribed *C. caryaecola* Osten Sacken as a new species because he did not consider Osten Sacken's name to be valid, Osten Sacken having described it on the basis of the gall only. Unfortunately, Felt misidentified Osten Sacken's species, so Felt's homonym must be renamed here. Felt (1921) had a broad concept of the gall of this species that included three kinds of conical galls shown here to yield three separate *Caryomyia* spp. According to Felt's unpublished notebook, the lectotype larva, #a1786, from Hamburg, NY, came from bitternut. This narrows the conical type gall, now lost, to either *C. ansericollum* or *C. spinulosa*, but the type larva with its triangular spatula tooth, fits larvae taken from *C. ansericollum* galls. In fact, Felt's (1921) gall description matches the gall of *C. ansericollum*, and the gall is the same as Felt (1915, Pl. 4, Fig. 9) referred to in his 1921 synonymy, not the two photos of Felt (1921, Pl. 10, Figs. 2-3), that he refers to in the 1921 description. The gall was also correctly figured in Felt (1906, Pl. 1, Fig. 21).

Etymology.—The name *ansericollum* is a noun in apposition coined from the Latin *anser* (goose) and neck (*collum*) with reference to the long, usually sinuous neck of these galls.

Affinities.—This species is one of three found only on bitternut; each one appears more similar to species on the *Eucarya* section than to one another. Females (male unknown), pupae, and larvae of *C. ansericollum* are generally similar to those of *C. inclinata*, q.v. for further discussion of the group of species that have conical, woody, apically digitate galls.

Collections of galls (all from *Carya cordiformis*).—**INDIANA:** Plainville. **MARYLAND:** Ellicott City; Kensington; Ridgely; Wheaton. **NEW JERSEY:** Worthington. **NEW YORK:** Hamburg; Ithaca; Ravana. **PENNSYLVANIA:** Pavia. **VERMONT:** Guilford.

VIRGINIA: Rt. 81, mi. 13.9, Washington Co. **WEST VIRGINIA:** Falling Waters.

Specimens of *C. ansericollum* examined.—**INDIANA:** Plainville, IX-7-2004 (larvae). **MARYLAND:** Ellicott City, IX-2-2000 (larva); Kensington, VIII-11 and IX-28-2000 (larvae); Ridgely, IX-23-1999 & X-6-2005 (larvae); Wheaton, IX-1-1994 (larvae). **NEW JERSEY:** Worthington, IX-8-2000 (larvae; 2 ♀, 3 pupae, em. IV-2001). **NEW YORK:** Hamburg, IX-17-1907, E.P. Felt (larva, lectotype); Ithaca, IX-3-2003 (larvae). **VERMONT:** Guilford, IX-7-2005 (larvae). **WEST VIRGINIA:** Falling Waters, IX-27-2003 (larvae), VI-21-2004 (larvae), IX-2005 (2 ♀, pupae, em. IV-19 to 25, 2006).

Caryomyia antennata Felt

Caryomyia antennata Felt 1909: 292.

Description.—*Gall* (Figs. 158-159): Occasional, on *Eucarya* hickories; on or closely adjacent to veins of lower leaf surface; 3-6 mm in height, spheroidal, usually tapered to conical apex, covered with moderate to thick, white to tan hair not quite obscuring gall surface; base with central hemispherical pedicel fitting into corresponding leaf depression, some short exfoliation of leaf surrounding connection; wall woody, uniformly thick, larval chamber narrowed at both ends, with longitudinal ridges. This gall could be mistaken for one of the less hairy *C. holotricha* or *C. aggregata* galls, but galls of those species have a basal excavation rather than the prominent hemispherical connection to the leaf of the present species. The larval chamber of this gall is unique in that it extends into this connection.

Adult: **Head:** Antenna with 12 regular flagellomeres; male flagellomeres binodal with definite internode and neck, circumfila with short loops, their bases widely separated; first few female flagellomeres with basal circumfilum weakly anastomosing on venter. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4 segmented. **Thorax:** Wing length 3.1-3.3 mm in female (n=10). **Male abdomen:** Third through eighth tergites each with posterior setae separated into two lateral groups, in mostly double row; eighth tergite not more weakly sclerotized than seventh. **Genitalia:** Hypoproct widest on posterior third, slightly concave posteromesally, margin setose except in con-

cavity, setulose on dorsum only on posterior third; apex of aedeagus slightly rounded. **Female**

abdomen: Third through eighth tergites each with posterior setae in three rows, diminishing to two rows mesally, continuous across sclerite except interrupted mesally on eighth. Ninth segment pliable except fairly wide dorsal sclerite, setae long but sparse. Cerci elongate-ovoid, pointed apically, pigmented, fused dorsally on basal third.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 2.0–2.9 mm (n=10). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 324) with acutely triangular anterior tooth, shaft wide at both ends and narrowing towards midlength. Papillae without setae, their bases not raised. Lateral papillae numbering 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments with sparse verrucae at midlength dorsally and with rows of tiny, horizontal rows of pointed spicules antero- and posteroventrally. Terminal segment shorter than eighth. **Second instar:** Length 2.4–3.5 mm (n=8). Collar segment with patch of enlarged spicules on each side. Spatula with elongate, acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, papillae asetose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Lectotype* male, here designated, leftmost specimen of three specimens on slide #a1944, emerged 1909 from *Carya* sp. galls, Nassau, New York, deposited in New York State Museum, Albany. *Paralectotypes:* male, on same slide as lectotype (another specimen on same slide is a female *Neolasioptera*, not part of type series); 2 females, each on separate slide, same data as lectotype except with mounting date of "2 May '09"; one female with same data as lectotype with mounting date of "3 May '09," belongs to a different, undetermined species of *Caryomyia*. Two cards labelled with the type number, a1944, in the Felt collection bear galls, all of one kind, from which this species was reared. They appear at first glance to have no hair covering but they

have been wetted and worn by handling and weather.

Etymology.—The name *antennata* is a Latin adjective that refers to the antennae, but further context is not manifest.

Affinities.—The gall of this species is unique for the larval chamber extending into the conical basal connection with the leaf. Its closest relative among the other woody gall makers with long antennal flagellomeres and an apically rounded aedeagus is not apparent.

Biological notes.—First noticed as full-size, hard galls in eastern West Virginia in early July, all were inhabited by second instars. By early August galls contained either a second or third instar. Full-grown larvae fully fill the larval chamber.

Collections of galls.—**ARKANSAS:** Palestine (*ovata*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Hartland (*ovata*); Harwinton (*ovata*); Litchfield (*ovata*) Meriden (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Westchester (*ovata*). **GEORGIA:** Forsyth (*ovata*); Lizella (*ovata*). **ILLINOIS:** Highland (*laciniosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Brownsville (*ovata*); Winchester (*laciniosa*). **MARYLAND:** Lusby (*glabra, tomentosa*); Piney Grove (*ovata*); Ridgely (*glabra*). **MASSACHUSETTS:** Boston (*tomentosa*); Great Barrington (*ovata*); Holyoke (*ovata*); Merrimac (*ovata*); Petersham (*ovata*). **NEW HAMPSHIRE:** Greenland (*ovata*); Seabrook (*ovata*). **NEW YORK:** Herkimer (*ovata*); Kinderhook (*Carya* sp.); Nassau (*Carya* sp.); New York (*Carya* sp.). **TENNESSEE:** Mohawk (*tomentosa*). **WEST VIRGINIA:** 6 mi NW Hedgesville (*ovata*).

Specimens of *C. antennata* examined.—**ARKANSAS:** Palestine, IX-10-2004 (larva). **CONNECTICUT:** Amston, IX-17-1999 (larvae); Danbury, IX-6-2005 (larvae; pupa, excised from gall V-2-2006); Hartland, IX-7-2005 (larva); Meriden, IX-16-1992 (larva). **GEORGIA:** Lizella, X-12-1993, J. & R. Payne (larva). **INDIANA:** Spencer Co., IX-19-1995 (larva). **KENTUCKY:** Brownsville, IX-21-1995 (larvae); Winchester, IX-22-1995 (larvae). **MARYLAND:** Lusby, IX-16-2003 (larvae); Ridgely, IX-11-2003 (*glabra*). **NEW YORK:** Herkimer, IX-4-2003 (larvae); Nassau, E.P. Felt (type series of 2♂, 3♀, em. 1909; also pupae, larva).

Caryomyia arcuata Gagné, new species

Description.—**Gall** (Figs. 141–142): Rare, on *Eucarya hickories*; found singly on lower leaf surface

between veins; 2.5–2.7 mm high, base lunulate, its sides flared toward apex and surrounding base of central, apically pointed cone; hairless, not sticky, brown to purple; base with shallow, central excavation; larval chamber located at base of gall, ovoid, lined with yellowish membrane, contrasting with brown to purple, large-celled, spongy, viscous tissue surrounding larval chamber, a bundle of longitudinal fibers present between larval chamber and gall apex. This gall shows some resemblance to that of *C. sanguinolenta* from which it differs in the sides of the gall being conspicuously flared upwards around the apical cone.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 1.5–1.8 mm (n=8). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 304) with anterior tooth elongate-triangular but notched apically, the shaft widened anteriorly and tapered behind. Papillae without setae, their bases not raised. Lateral papillae 2–3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments covered on dorsum at midlength with verrucae and on ventral anterior and posterior thirds with horizontal rows of spicules. Terminal segment shorter than eighth. **Second instar:** Length 0.9–1.0 mm (n=5). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—**Holotype:** Third instar, from gall on *C. tomentosa*, St. Clair, Missouri, IX-8–2004, R.J. Gagné, deposited in USNM.

Etymology.—The name *arcuata* is a Latin adjective meaning curved, with reference to the recurved base of the gall.

Affinities.—See under *C. sanguinolenta*, from which this species differs in the shape of the gall.

Collections of galls.—**ALABAMA:** Auburn (*tomentosa*). Greenville (*tomentosa*). **FLORIDA:** Gainesville (*tomentosa*). **ILLINOIS:** Rock Island (*tomentosa*, B.D. Walsh). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*tomentosa*). **MISSOURI:** Con-

way (*texana*); St. Clair (*tomentosa*). **SOUTH CAROLINA:** Georgetown (*tomentosa*).

Specimens of *C. arcuata* examined.—**ALABAMA:** Auburn, IX-19–2000 (larva); Greenville, IX-20–2000 (larvae). **FLORIDA:** Gainesville, IX-21–2000 (larvae). **MISSOURI:** Conway IX-8–2004 (larva); St. Clair, IX-8–2004 (larva). **SOUTH CAROLINA:** Georgetown X-1–2005, D. & B. Gagné (larva; pupa, excised from gall III-28–2006).

Caryomyia asteris Gagné, new species

Description.—**Gall** (Figs. 32, 100–101): Rare, on *Eucarya* hickories, not found east of the Appalachian Mountains or Ohio, except for one specimen from near the South Carolina Coast; on lower leaf surface, between veins; 2.0–2.5 mm in height, short-obconic, the apex almost flat, expanded laterally into flat, circular, horizontal disk with raggedly serrate edge, with small, central umbo at apex usually still bearing thin, circular, disk (the ephemeral cut-out leaf lamina beneath which gall issued; easily detachable and often no longer present) equal to more than 1/3 expanded gall diameter; surface covered with fine, short, brown hairs not obscuring gall surface; base tapering to small, conical pedicel; leaf with some irregular exfoliation surrounding connection with gall and showing discolored, slight convexity on reverse side of leaf; wall thin, becoming brittle, larval chamber glabrous, longitudinally striate. The architecture of this gall is generally similar to that of *C. inanis* except that the extraneous tissue surmounting the larval chamber is disposed horizontally rather than vertically and is more papery in *C. inanis*.

Adult and pupa: Unknown.

Larva: Third instar: Length 2.1–2.5 mm (n=7). Body elongate-fusiform, anterior end broadly rounded, posterior end tapering to weak point. Head directed anteroventrally. Spatula (Fig. 300) with parallel-sided, apically-notched tooth and narrow shaft. Papillae without setae, raised, especially those of dorsal, pleural, and terminal papillae. Lateral papillae 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments completely covered with verrucae. Terminal segment as long as eighth and nearly pointed. **Second instar:** Not seen.

Type material.—**Holotype:** Third instar, (right-most of 3 larvae on slide), from gall on *C. ovata*, I 64 rest stop, 2 mi E US 231, Spencer Co., Indiana, IX-20–1995, R.J. Gagné, deposited in USNM.

Etymology.—The name *asteris* is a Latin adjective meaning starlike with reference to the radiate, flared rim of the gall.

Affinities.—See under *C. inanis*.

Collections of galls.—ILLINOIS: Marshall (*tomentosa*). INDIANA: Richmond (*tomentosa*); Spencer Co. (*ovata*). MISSISSIPPI: Noxubee Natl Wildlife Ref., Oktibbeha Co. (*tomentosa*). OHIO: Gypsum (*ovata*, Wells 1916: Fig. 32); Huron Co. (*ovata*, Sears 1914: Fig. 13).

Specimens of *C. asteris* examined.—ILLINOIS: Marshall, IX-7-2004 (larva). INDIANA: Richmond, IX-7-2004 (larvae); Spencer Co., IX-20-1995 (larvae).

Caryomyia biretta Gagné, new species

Description.—*Gall* (Figs. 16, 144): Rare, on *Eucarya* hickories, but not E of Appalachian Mts.; on lower leaf surface between veins; 2.5–3.0 mm high, depressed-spheroid, broad apical surface flat to slightly concave with central elongate nipple; hairless, not sticky, green to purple; base with central, shallow, central excavation, the leaf slightly convex and discolored on reverse side; larval chamber basal, depressed-ovoid, lined with yellowish membrane, contrasting with purple, woody tissue surrounding larval chamber, especially laterally. Externally this gall simulates that of *C. inflata* except that the latter does not have the tassel at the apex. The internal shape of these two galls is very different with the larval chamber of *C. biretta* being surrounded by thick walls and that of *C. inflata* being thin walled and surmounted by a false chamber.

Adult and pupa: Unknown.

Larva: **Third instar:** Length 1.7–2.6 mm (n=5). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 302) with tooth nearly parallel-sided, the apex slightly flaring and weakly notched, the shaft widened anteriorly and tapered behind. Papillae without setae, their bases not raised. Lateral papillae 2–3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments covered on dorsal midlength with verrucae and on ventral anterior and posterior thirds with horizontal rows of spicules. Terminal segment shorter than eighth. **Second instar:** Length 0.8 mm (n=1). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular tooth and longer, wider, con-

cave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype:* Third instar (rightmost specimen of three larvae on slide), from gall on *C. ovata*, Petersham, Massachusetts, IX-6-2000, R.J. Gagné, deposited in USNM.

Etymology.—The name *biretta* is a Latin noun in apposition meaning beret, simulated by the outline of this gall.

Affinities.—See under *C. sanguinolenta*, from which this species differs in the shape of the gall.

Collections of galls.—CONNECTICUT: Hopewell (*ovata*); Meriden (*ovata*); Phoenixville (*ovata*).

GEORGIA: Lizella (*ovata*). ILLINOIS: Dexter (*laciniosa*). MASSACHUSETTS: Petersham (*ovata*). NEW HAMPSHIRE: Barrington (*ovata*). OHIO: Hocking Co. (*Carya* sp., Wells 1916: Fig. 16. Wells wrote that his gall was also illustrated in Thompson 1915: Fig. 228, but Thompson's gall belongs instead to *C. inflata*); St. Clairsville (*tomentosa*).

Specimens of *C. biretta* examined.—MASSACHUSETTS: Petersham, IX-6-2000 (larvae). NEW HAMPSHIRE: Barrington, IX-22-1994 (larva). OHIO: St. Clairsville, 6-IX-2004 (larvae).

Caryomyia caminata Gagné, new species

Description.—*Gall* (Figs. 7, 108–109): Rare, on *Eucarya* hickories; on lower leaf surface, between veins; 5 mm in height, columnar, widest near base, tapering to apex, a small aperture present at apex; matte, hairless, green, turning brown; base of gall truncate, leaf with slight exfoliation around connection forming short, tubular socket, a corresponding convexity present on opposite leaf surface; two-chambered, the basal larval chamber about 1/4 length of gall, ovoid, smooth, longitudinally ridged, the apical false chamber also ridged and open or closed apically, the partition between chambers with minute, central perforation. This gall is known from only two specimens, one a figure in Wells (1916).

Adult and pupa: Unknown.

Larva: **Third instar:** Length 2.2 mm (n=1). Body elongate-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 297) with anterior tooth gradually narrowing to erose apex, the shaft broad anteriorly, tapering beyond. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Six dorsal papillae on first 7 ab-

dominal segments. Abdominal segments dorso-laterally with verrucae along line of dorsal papillae and with horizontal rows of pointed spicules anteroventrally but not posteroventrally. Terminal segment shorter than eighth. **Second instar:** Not seen.

Type material.—*Holotype*: Third instar, from gall on *C. ovata*, I 64 rest stop, 2 mi E U.S. 231, Spencer Co., Indiana, IX-20-1995, R.J. Gagné, deposited in USNM.

Etymology.—The name *caminata* is a Latin adjective for chimney-like, referring to the general shape of the gall with the apical aperture.

Affinities.—The gall vaguely resembles another bicameral gall, that of *C. ovalis*, but the wall of the latter is thicker and shiny, not brittle, foliaceous, and matte as in the present species. The gall of *C. tubicola* is also elongate-cylindrical and set into a leaf socket, but it does not have a false chamber; also the larva of *C. tubicola* has only 4 dorsal abdominal papillae, while the present species has 6.

Collections of galls.—**INDIANA:** Spencer Co. (*ovata*). **OHIO:** Hocking Co. (*glabra*, Wells 1916: Fig. 7).

Specimens of *C. caminata* examined.—**INDIANA:** Spencer Co., IX-20-1995 (larva, holotype).

Caryomyia caryae (Osten Sacken)

Diplosis caryae Osten Sacken 1862: 191; Felt 1909:293 (*Caryomyia*).

Hormomyia arcuaria Felt 1908: 388; Felt 1918: 46 (*Caryomyia*). **New synonym.**

Description.—*Gall* (Figs. 18, 20–20a, 55–58): Common, found on *Eucarya* hickories; single or clustered, on lower leaf surface, usually between veins but may occur on vein; 2.5–3.5 mm in height, spheroidal, sometimes bulging out to one side at midlength, apex with short umbo, less often gall subcylindrical and constricted near basal third; green or yellow, becoming tan to red or brown, hairless, more or less sticky, variably covered with small resin glands; base with weak to prominent conical pedicel in center of circular indentation, leaf in most specimens slightly exfoliate surrounding base of gall, in subcylindrical form more conspicuously so; wall firm, brittle, of uniform thickness, usually thin, larval chamber shaped as for gall, yellow, brown, or purple,

glabrous, with longitudinal ridges. This gall is generally similar to that of *C. shmoor*, but the gall of the latter is conspicuously narrow at its apical third, while the present gall is more evenly spheroidal.

Adult: Head: Antenna with 12 flagellomeres, in male usually with additional short 13th flagellomere without circumfila and in the two New Waverly Texas, females, 13–14 flagellomeres; each of the regular 12 male flagellomeres (Fig. 239) binodal with definite internode and neck, circumfila loops short, their bases widely separated; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. **Thorax:** Wing length 3.4–4.0 mm in male (n=10), 2.9–3.9 mm in female (n=10). **Male abdomen:** Third through eighth tergites each with posterior setae separated into two lateral groups, in 1 to 3 horizontal rows; eighth tergite not more weakly sclerotized than seventh. Genitalia: hypoproct nearly parallel sided, weakly concave posteromesally, the margin partly setose; apex of aedeagus convex. **Female abdomen:** Third through seventh tergites each with posterior setae as for male; eighth tergite more weakly sclerotized than preceding tergite, with posterior setae only laterally and not as long as on preceding tergite. Ninth segment pliable except for dorsal sclerite that widens from base to apex, setae sparse laterally and ventrally, many longer than cerci. Cerci ovoid in lateral view, fused dorsally for about 2/3 length.

Pupa (Figs. 197–198): Antennal bases oblique in ventral view, converging and narrowing anteriorly, their rounded apices closely adjacent. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar (Figs. 218–219): Length 2.4–3.6 mm (n=10). Body dorsoventrally flattened, elongate-ovoid, rounded at ends, segments convex. Head directed antero-ventrally. Spatula (Fig. 282) with 2 widely separated anterior teeth, shaft widest anteriorly, narrowing abruptly to posterior half. Papillae mostly on short lobes, dorsals and pleurals except for prothorax with setae, also ventrals with setae on first through seventh abdominal segments. Lateral papillae usually 2, occasion-

ally 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Body entirely covered with verrucae. Terminal segment as long as eighth. **Second instar:** Length 1.0–1.5 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with apically pointed tooth and elliptical or triangular shaft. Bases of dorsal and pleural papillae raised and all short-setose except asetose on prothorax. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Diplosis caryae* Osten Sacken: *Lectotype*, here designated, third instar (excised from galls of the more common, less robust, sub-spherical gall form), from gall on *Carya* sp., Washington, DC., collected by Osten Sacken, deposited in USNM. *Paralectotypes*, same data as lectotype, a second instar excised from a separate gall, and one remaining gall, in USNM; also male(s) and female(s), mentioned by Osten Sacken (1862) but now lost. For unstated reasons, Felt (1921) wrote that the adult of Osten Sacken's type series "could hardly be a *Caryomyia*" and was "probably an inquiline." Nothing about Osten Sacken's description of the adult would disallow it as a *Caryomyia*. Perhaps Felt objected to the April date of emergence that Osten Sacken (1862) reported. Felt (1921) thought that the adult emerged "probably early in June," possibly because that is when galls of this species become apparent, but my rearings show that adults of this species and other *Caryomyia* species emerge in March and April in the Washington, DC area.

Hormomyia arcuaria Felt: *Holotype*, ♂, vicinity of Worcester, Massachusetts, reared from *Carya* sp., Thompson # 254–255, Felt # C1104z, deposited in Felt Collection. This specimen came from a smooth, subglobular, nippled gall (Felt 1908). Felt (1921) later added that this male was separated from a series of adults reared from an apparently typical lot of *C. caryae* galls. The holotype is a teneral specimen of *C. caryae* with the flagellomeres not yet fully expanded (cf. Felt 1921: 99, fig. 9), which may be the reason Felt differentiated the specimens from the remainder of the series.

Etymology.—The name *caryae* means "of *Carya*," and *arcuaria* means arcuate. The latter name was evidently coined for the arched antennal circumfila as drawn in Felt (1921: 99, fig. 9).

Affinities.—As mentioned in the gall description, two intergrading kinds of galls are formed by *C. caryae* as defined here (compare Figs. 55–56

with 57–58). This species is apparently related to *C. hirtiglobus* and *C. shmo* because of the general conformation of the gall with its acute-conical connection to the leaf and similarity of the larvae, most conspicuously in the widely spaced teeth of the third instar spatula. Males of all three species have comparably shaped flagellomeres and similar genitalia and abdominal tergite setation. Third instars of this group of three species have setae on the dorsal and pleural papillae except that *C. caryae* lacks them on the prothorax; *C. caryae* and *C. shmo* carry the same pattern along on the second instar but *C. hirtiglobus* lacks any papillar setae on that instar. Pupae of *C. caryae* have antennal bases slightly longer than those of *C. hirtiglobus* and *C. shmo*, and differ also in that the apices touch one another.

Biological notes.—In central Maryland, galls were first noticed in late May when they contained first and second instars, but the galls were immature, soft and very sticky. Small, barely noticeable adjacent galls with first instars were recognizable but smaller and stickier. Through the first week of August most galls are brittle and contain second instars, but during this period occasional galls may contain a third instar. After early August galls usually contain third instars. Adults were reared in early April the following year.

Collections of galls.—Collections of the subcylindrical form of this gall are marked with an asterisk in this list. In addition to the following galls from Canada and United States, I have photographs of some of the subcylindrical gall type from Tamaulipas, Mexico. **ALABAMA:** Ashville (*tomentosa*); Auburn (*glabra*, *ovata*, *pallida*, *tomentosa**); Birmingham (*pallida*); 2 mi S DeQueen (*texana*, *tomentosa*). Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata**, *pallida**). **ARKANSAS:** Beulah (*tomentosa*); Chester (*texana*); 3 mi S Harrison (*tomentosa**); London (*tomentosa*); Magazine Mt., Logan Co. (*ovata**, *texana**, *tomentosa**); Osage (*texana*); Palestine (*ovata*); Piney (*texana*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Hartland (*ovata*); Harwinton (*ovata*); Hopeville (*ovata*); Litchfield (*ovata*); Meriden (*ovata*); New Haven (*glabra*); Oakville (*glabra*, *ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Southbury (*glabra**, *tomentosa**); Southington (*ovata*); Westchester (*ovata*). **FLORIDA:** Avon Park (*floridana*); Chattahoochee (*glabra*, *tomentosa*); Gainesville (*glabra*, *tomentosa*); Lake City (*tomentosa*); **GEORGIA:** Carnesville (*glabra*); Forsyth

(*glabra*, *ovata*); 8 km E Fort Valley (*pallida*); Lake Park (*glabra*); Lizella (*ovata*, *tomentosa*). **ILLINOIS**: Dexter (*laciniosa*, *tomentosa*); Highland (*laciniosa*); Marshall (*tomentosa**). **INDIANA**: Richmond (*tomentosa*); Spencer Co. (*ovata*). **KENTUCKY**: Brownsville (*tomentosa*); Grayson Lake St. Pk, Carter Co. (*tomentosa*); Morehead (*tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata**); Pennyville St. Pk, Christian Co. (*ovata*); Winchester (*laciniosa*, *ovata*). **LOUISIANA**: Lake Bistineau St. Pk, Webster Parish (*texana*, *tomentosa*). **MARYLAND**: Beaver Dam (*tomentosa*); Beltsville, USDA Agricultural Research Center (*glabra*, *tomentosa*); Brighton (*tomentosa**); Calverton (*tomentosa*); Clarksburg (*glabra*, *tomentosa*); College Park (*tomentosa*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa**); Lusby (*glabra*, *tomentosa*); Piney Grove (*ovata*); Potomac (*tomentosa*); Ridgely (*glabra*, *tomentosa*); St. Leonard (*tomentosa**); Silver Spring (*tomentosa*); Snow Hill (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra*, *tomentosa*). **MASSACHUSETTS**: Bolton (*ovata*); Great Barrington (*ovata*); Holyoke (*ovata*); Leominster (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); Worcester (*tomentosa*); Wrentham (*ovata*). **MISSISSIPPI**: Natchez Trace Pkwy, Mile 193, Choctaw Co. (*glabra*, *pallida*, *tomentosa*); Noxubee Natl Wildlife Ref., Oktibbeha Co. (*tomentosa*); 7 mi E Starkville (*ovata*, *pallida*, *tomentosa*). **MISSOURI**: Conway (*ovata*, *texana*); Crowley Ridge Roadside Pk, Stoddard Co. (*glabra*, *tomentosa*); Holly Ridge State For., Stoddard Co. (*glabra**; *tomentosa**); Rolla (*texana*); Wildwood (*tomentosa*). **NEW HAMPSHIRE**: Barrington (*ovata*); Dover (*ovata*); Exeter (*ovata*); Seabrook (*ovata*). **NEW YORK**: Albany (*Carya* sp.); E. Schodack (*Carya* sp.); Herkimer (*ovata*); Ithaca (*ovata*); Nassau (*Carya* sp.); New York (*Carya* sp.); Ravenna (*glabra*, *ovata*); Saratoga Springs (*ovata*); Shokan (*glabra*). **NORTH CAROLINA**: Alamance (*tomentosa*); Alberta (*glabra*); Dertches (*glabra*, *tomentosa*); Providence (*glabra*, *tomentosa*); Rowland (*tomentosa*); Wise (*tomentosa*). **OHIO**: Hocking St. For., Hocking Co. (*glabra*, *ovata*); Hocking Co. (*ovata*, *tomentosa*, Wells 1916: Figs. 18, 20–20a); St. Clairsville (*tomentosa*); Summerford (*tomentosa*); Yellow Springs (*glabra*). **OKLAHOMA**: Sallisaw (*tomentosa*). **ONTARIO**: Dundas (*ovata*). **PENNSYLVANIA**: Kirby (*ovata*); Julian (*glabra*); Millsboro (*glabra*); Schellsburg (*glabra*, *ovata*). **SOUTH CAROLINA**: Dillon (*tomentosa*); Georgetown (*tomentosa*). **TENNESSEE**: Crossville (*pallida*); Dandridge (*tomentosa**); Dickson (*tomentosa*). **TAMAULIPAS**: SW of Ciudad Victoria (*ovata*, var. *mexicana*; photos only). **TEXAS**: Daingerfield St.

Pk, Morris Co. (*tomentosa*); New Waverly (*tomentosa*). **VIRGINIA**: Warren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*); Carson (*glabra*); Dinwiddie (*glabra*, *tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); Radford (*tomentosa*); Skippers (*tomentosa*). **WASHINGTON, DC**: National Arboretum (*glabra*, *tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA**: 6 mi. NW Hedgesville (*ovata*, *tomentosa*).

Specimens of *C. caryae* examined.—**ALABAMA**: Auburn, IX-19–2000 (larvae). **ARKANSAS**: Beulah, IX-10–2004 (larva); Chester, IX-9–2004 (larvae); 3 mi S Harrison, VII-22–1988 (larva); Osage, IX-9–2004 (larva). **CONNECTICUT**: Amston, IX-19–1994 & IX-17–1999 (larvae); Phoenixville, IX-20–1994 (larvae). **FLORIDA**: Avon Park, XI-7–13–2002, K. Hibbard (larva). **GEORGIA**: 8 km E Fort Valley, IX-11–1993, J. & R. Payne (larvae; 2 ♀, pupae, em. IV-1994). **ILLINOIS**: Marshall, IX-7–2004 (larvae). **INDIANA**: Spencer Co., IX-20–1995 (larva). **KENTUCKY**: Brownsville, IX-21–1995 (larvae); My Old Kentucky Home St. Pk, Nelson Co., VII-1988 (larva); Winchester, IX-22–1995 (larva). **MARYLAND**: Beltsville, USDA Agricultural Research Center, V-5–1998, VII-1–1998, VII-5–1998 & VII-1–2000 (larvae); Brighton, X-10–1993 & X-8–1994 (larvae; 5 ♂, 5 ♀, pupae, em. IV-1995); Clarksburg, X-4–2005 (pupae, 19 ♂, em. IV-5 to 17–2006); Gaithersburg, X-4–1994, VII-20–2000 (larvae); Lusby, IX-14–2005 (pupae, ♀, em. IV-2–2006); Ridgely, X-1999 (larvae; ♂, ♀, pupae, em. IV-2000); Silver Spring, IX-17–1993 & X-24–1993 (larvae); Spencerville, IX-18–2004 (larvae); Wheaton, IX-19–1993 (larvae). **MASSACHUSETTS**: Leominster, IX-21–1994 (larvae); vic. Worcester, M.T. Thompson (larva; ♂ (holotype of *C. arcuaria*), ♀); Wrentham, IX-20–1994 (larvae). **MISSOURI**: Conway, IX-8–2004 (larva); Holly Ridge State For., Stoddard Co., VII-1988 (larva). **NEW HAMPSHIRE**: Barrington, IX-22–1994 (larvae; ♂, ♀, pupae, em. IV-1995); Dover, IX-21–1994 (larva); Exeter, IX-21–1994 (larva). **NEW YORK**: E. Schodack, E.P. Felt (larva); Nassau, E.P. Felt (16 ♂, 13 ♀); New York, E.P. Felt (larva; 3 ♀); Saratoga Springs, IX-25–1994 (larvae). **OHIO**: Hocking St. For., Hocking Co., IX-19–1995 (larva), Yellow Springs, IX-7–2004. **OKLAHOMA**: Sallisaw, IX-9–2004 (larvae). **ONTARIO**: Dundas, VIII-17–1995 (larvae). **TENNESSEE**: Dandridge, IX-12–2004 (larva). **TEXAS**: New Waverly, X-6–2001 (3 ♂, 10 ♀, pupae, em. IV-2002). **WASHINGTON, DC**: type series of *C. caryae*, locality not specified further, *C. glabra*; National Arboretum, X-13–1997

(larvae); Walter Reed Army Medical Center, IX-2000 (larvae). **WEST VIRGINIA:** 6 mi. NW Hedgesville, IX-12 & 19-1999 (larvae).

Caryomyia caryaecola (Osten Sacken)

Cecidomyia caryaecola Osten Sacken 1862: 192; Felt 1915: 222 (*Caryomyia*).

Description.—*Gall* (Figs. 12–13, 70–71).—Common, on *Eucarya* hickories; single or in groups, attached to vein on lower leaf surface; 4.8–8.0 mm in height, onion-shaped, upright to leaning, tapered from rounded base to pointed apex; hairless, glabrous, green or yellow, becoming tan to brown; base broadly rounded with large, central conical pedicel in deep, circular indentation; wall hard, of uniform thickness, larval chamber shaped as for gall, glabrous, with longitudinal ridges. This gall vaguely resembles those of *C. caryae* and *C. shmoo* in its connection to the leaf and its hard, hairless surface, but it is definitely onion-shaped and, unlike the other two, it is always attached to veins instead of the lamina.

Adult (female only): Head: Antenna with 12 flagellomeres, flagellomeres with 2 or, on more basal flagellomeres, a third horizontal circumfilum connected by vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4 segmented. **Thorax:** Wing length 2.5 mm (n=1). **Abdomen:** Third through seventh tergites each with posterior setae continuous across width, in 2–3 rows laterally, tapering to 1–2 rows medially; eighth tergite with 3–4 weak lateral posterior setae. Ninth segment (generally as for Fig. 260, but not well displayed on slide mount) pliable except for slender dorsal sclerite, setae shorter than cerci, in two groups, one dorsolateral, one ventral. Cerci elongate-ovoid in lateral view, fused dorsally on basal third.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 2.6–4.4 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 286) with short tooth, barely narrowing

from base to apex, nearly parallel-sided, shallowly notched apically, on some specimens merely erose, and with elongate, narrow shaft becoming broader anteriorly. Papillae without setae, bases of dorsals and pleurals somewhat raised. Lateral papillae usually 4, occasionally 3, on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments extensively covered with verrucae. Terminal segment shorter than eighth. **Second instar:** Length 0.7–1.1 mm (n=5). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae raised, papillae with long setae. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Syntypes*: Four galls from *C. tomentosa* (as *C. alba*), Washington, DC, C. Osten Sacken, deposited in USNM.

Etymology.—The name *caryaecola* is a noun meaning hickory inhabitant.

Affinities.—This species may be related to *C. caryae* (q.v.) and its two close relatives. As in those species, *C. caryaecola* has setose papillae in the second instar but, unlike them, the third instar papillae are asetose. The pupae of *C. caryaecola* have antennal bases with apicolateral points unlike those of *C. caryae* and relatives in which the pointed apices are mesally situated. The gall of the present species shares with the other three a similar recessed, conical base and thin, but hard wall.

Biological notes.—In central Maryland, galls appear by May 23. At first they are light green and soft, but grow very quickly so that by June 9 and until June 15, galls are mostly full-size, green, and brittle, and still contain first instars. By June 17, most galls are hardened and contain second instars. Until the second week of August most galls still contain second instars, but an occasional gall contains a third instar. Adults emerge in spring from a subapical hole near the thinnest part of the gall. In Sallisaw, Oklahoma, I saw hundreds of partially developed galls that contained dead, dried first instars. All apparently died of the same cause and gall growth was terminated. Those partially developed galls correspond to the gall drawn in Wells (1916, Fig. 13), a stunted example of the one of the same species he drew in his Fig. 12.

Collections of galls.—**ALABAMA:** Auburn (*glabra*, *ovata*, *tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata*). **ARKANSAS:** Beulah (*tomentosa*); Chester (*texana*); London (*tomentosa*); Magazine Mt., Logan

Co. (*texana*); Piney (*texana*). CONNECTICUT: Amston (*ovata*); Meriden (*ovata*); New Haven (*glabra*); Phoenixville (*ovata*); Plainfield (*ovata*); Westchester (*ovata*). GEORGIA: Forsyth (*glabra, ovata*); Lizella (*ovata, tomentosa*). ILLINOIS: Highland (*laciniosa*); Marshall (*tomentosa*). INDIANA: New Castle (*glabra*); Spencer Co. (*ovata*). KENTUCKY: Pennyrite St. Pk, Christian Co. (*glabra*); Winchester (*laciniosa*). MAINE: Eliot (*tomentosa*). MARYLAND: Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Clarksburg (*tomentosa*); College Park (*glabra*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*glabra, tomentosa*); Ridgely (*tomentosa*); St. Leonard (*tomentosa*); Silver Spring (*glabra*); Spencerville (*tomentosa*); Wheaton (*glabra*). MASSACHUSETTS: vic. Worcester (*Carya* sp., Thompson 1915: 89, Fig. 226); Wrentham (*ovata*). MISSISSIPPI: Natchez Trace Pkwy, Mile 123, Rankin Co. (*tomentosa*); nr. Sessums, Oktibbeha Co. (*ovata*). MISSOURI: Conway (*texana*); Holly Ridge State For., Stoddard Co. (*glabra, tomentosa*); Wildwood (*tomentosa*). NEW HAMPSHIRE: Kingston (*ovata*). NEW YORK: Nassau (*Carya* sp.); New York (*Carya* sp., Beutenmüller 1904: 27, fig. 57). NORTH CAROLINA: Alberta (*glabra*), Providence (*glabra, tomentosa*). OHIO: Hocking Co. (*Carya* spp., Wells 1916: Figs. 12, 13); Huron Co. (*C. glabra*, Sears 1914: Fig. 17). OKLAHOMA: Sallisaw (*tomentosa*). TENNESSEE: Greene Co., I 81, Mile 38.5 (*tomentosa*); Jackson (*tomentosa*); Lebanon (*glabra*); Mohawk (*tomentosa*). VIRGINIA: Warren Co. Blue Ridge Pkwy Mile 4.6 (*ovata*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); I 81, Mile 13.9, Washington Co. (*ovata*). WASHINGTON, DC: Walter Reed Army Medical Center (*tomentosa*); unspecified (*Carya* sp. (syntypes)). WEST VIRGINIA: Beech Fork St. Pk, Wayne Co. (*tomentosa*); Cacapon (*ovata*); Cooper's Rock St. Pk, Preston Co. (*glabra*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. caryaecola* examined.—CONNECTICUT: Amston, IX-19-1994 (larvae). KENTUCKY: Winchester, IX-22-1995 (larvae). MARYLAND: Beltsville, USDA Agricultural Research Center, IX-28-1999, VII-1-2000, & VIII-25-2000 (larvae); Clarksburg, V-23-2000 (larvae) & X-4-2005 (pupal exuviae, IV-1-2006, & pupa, taken from gall IV-12-2006); Gaithersburg, X-4-1994 (larva); Kemp Mill, IX-6-2003 (larvae); Lusby, IX-16-2003 (♀, pupae, em. IV-10-2004); Spencerville, IX-7-2004 (larvae); Wheaton, X-12-1997 (larvae). MASSACHUSETTS: Wrentham, IX-20-1994 (larvae). OKLAHOMA: Sallisaw, IX-9-2004 (larvae). TENNESSEE: Tomahawk, IX-12-2004 (larvae). VIRGINIA: Huntley

Meadows Pk, Fairfax Co., VIII-30-2000 (larvae). WEST VIRGINIA: 6 mi NW Hedgesville, VIII-27-2000 (larvae).

Caryomyia cilidolium Gagné, new species

Description.—*Gall* (Figs. 51–52).—Occasional, known only from *C. cordiformis* of the *Apocarya* section; found singly, usually on lower leaf surface, rarely on upper, usually between but occasionally on veins; 3.1–3.9 mm in height, spheroidal, slightly longer than wide, base broadly rounded to truncate in profile, apex with small central nipple surrounded by extensive areola that with pressure can separate from gall; surface not sticky, occasionally slightly bumpy, tan to brown, with few to many short, fine, white hairs not obscuring surface, areola usually paler than surrounding surface; base with deep, wide, circular indentation; wall firm, brittle, almost uniformly thin, larval chamber glabrous, with longitudinal ridges. For notes on galls of related species, see below under affinities.

Adult: **Head:** Antenna with 12 flagellomeres. Each of the 12 male flagellomeres (as in Fig. 240) evenly cylindrical, girdled by 8–9 more or less parallel, occasionally interconnected, appressed circumfila interspersed with setae and covered with setulae. Female flagellomeres with anastomozing circumfila on venter (as in Fig. 241). Labella fused, the pair semicircular, setulose but asetose. **Thorax:** Wing length 2.1–2.2 mm (n=2) in male, 3.1 mm (n=1) in female. **Male abdomen:** Third through seventh tergites each with posterior setae continuous across width in mostly double, partly triple row; eighth tergite weakly sclerotized, with short posterior setae. Genitalia (Fig. 251): hypoproct broadest posteriorly and expanded posteroventrally to partly cover sides of aedeagus, each of the 2 lobes with 2–3 apical setae, dorsal surface completely covered with setulae; aedeagus tapering gradually from wide base to narrow apex; gonostylus dorsoventrally flattened, the tooth large, dorsoventrally compressed. **Female abdomen:** Third through seventh tergites each with posterior setae in 3 horizontal rows laterally, thinning to 2, then one, with slight medial interruption in setae; eighth tergite more weakly sclerotized than preceding tergite, with weak posterior setae numerous laterally, continuing mesally in single, sparse row. Ninth segment (as in Fig. 261) pliable except for slender dorsal sclerite, with numerous apico-lateral and ventral setae, none longer than the

cerci, the two groups separated laterally. Cerci elongate-ovoid in lateral view, pointed apically, fused dorsally for about 1/2 length.

Pupa (as in Figs. 193–194): Antennal bases elongate, in ventral view parallel, closely adjacent, rounded anteriorly, the apices dorsoventrally flattened. Face with longitudinal impression running along length, a slight anteromesal convexity posterior to each antennal base, and without antero-lateral pair of horizontal incisions. Frons and clypeus slightly convex. Abdominal tergal spinules all similarly small.

Larva: **Third instar** (Figs. 230–231): Length 2.0–2.9 mm (n=10). Body dorsoventrally flattened, elongate-ovoid, broadly rounded anteriorly, spindleform posteriorly. Head directed ventrally, surmounted dorsally by collar segment. Spatula (Fig. 277) with pointed anterior tooth and broad shaft. Papillae prominently raised above surrounding surface, without setae. Lateral papillae 2 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Body covered with verruciae. Terminal segment as long as eighth, rounded. **Second instar:** Length 1.0–1.4 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Six dorsal papillae on first 7 abdominal segments. Bases of dorsal and pleural papillae raised, papillae asetose.

Type material.—**Holotype:** Third instar, from gall on *C. cordiformis*, Ellicott City, Maryland, IX-2-2000, R.J. Gagné, deposited in USNM.

Etymology.—The name *cilidolum* is a noun combining the Latin *ciliatus* (fuzzy) and *dolum* (jar), with reference to the fuzzy, barrel-like gall.

Affinities.—*Caryomyia cilidolum*, *C. hirtidolum*, *C. tuberidolum*, and *C. viscidolum* form similarly shaped, spheroidal, thin walled galls (Figs. 43–52). At their apex is a large, circular areola surrounding a small central nipple. With a little pressure the circular apex can be broken off as a unit from the rest of the gall and forms the exit from which pupae emerge in spring. Galls of *C. cilidolum* occur only on bitternut of the *Apocarya* section of *Carya*, usually on the lower surface, and are covered with sparse, fine, short hairs. The other three species of this group occur on the *Eucarya* section. Galls of *C. hirtidolum* are hairy, much more so than those of *C. cilidolum*, so that the long hair obscures the gall surface. Galls of *C. tuberidolum* and *C. viscidolum* are both sticky, the former very much so and also bumpy and more spherical, the latter merely

slightly resinous and smooth. A major difference between these two last species is that *C. tuberidolum* occurs on the underside of the leaf (except for one example known to me) while *C. viscidolum* occurs on the upperside. This difference indicates a different egg-laying strategy by the female.

The pupal stages are known for all except *C. hirtidolum*, both sexes for *C. cilidolum* and *C. viscidolum*, and the female for *C. tuberidolum*. The known pupal and adult stages are each very similar among species, as are the larvae. Females of this group have the shortest ovipositors for the genus, and the pupae and male genitalia are distinctive. Pupae of this group lack spiny setulae on the pupal abdomen, as do *C. albipilosa* and *C. striolata*, but the second instars, unlike those two species, have a spatula.

One of the most striking characteristics of this group is the male antenna that, instead of having three separate circumfila as do all other *Caryomyia*, is instead girdled by 8–10 occasionally interconnected, unlooped circumfila reminiscent of those found in *Polystepha* of the tribe Asphondyliini. Females also have extra anastomozing strands of circumfila on the venter of the flagellomeres. Labella are completely joined mesally and lack setae, unlike all other *Caryomyia* species. Pupae in this group of species are distinct from all other *Caryomyia* in the shape of the antennal bases and the lack of horizontal facial incisions with protruding lower lips, but they do have a characteristic anteromesal facial prominence and a longitudinal facial furrow. The pupae show some similarity to that of *C. urnula*, except that the antennal horns are differently shaped. The third instars of this group are active, large, dorsoventrally flattened and have a spatula with a single anterior tooth. The head is situated ventrally with the dorsal part of the neck segment projecting over it. The dorsal and pleural papillae are on prominent lobes. The posterior end of the larva is generally rounded and as long as the previous segment.

The larval spatulas of the four species in this group are each distinctive. That of *C. cilidolum* has the anterior corners of the shaft rounded, that of *C. viscidolum* has a very long tooth compared to the shaft, and the shaft of *C. tuberidolum* is greatly widened anteriorly and posteriorly.

Biological notes.—In mid-June in the eastern panhandle of West Virginia fresh galls were green and brittle and with either second or third instars. In London, Arkansas, galls collected on Sept. 14 still contained second instars.

Collections of galls (all from *Carya cordiformis*).—ARKANSAS: London. CONNECTICUT: Meriden, Thomaston. ILLINOIS: Highland. INDIANA: Plainville. MARYLAND: Cabin John; Ellicott City; Kensington; Long Beach; Potomac; Ridgely; Wheaton. MISSOURI: Holly Ridge State For., Stoddard Co.; Oregon Co., junc. Rts. 11 & 142. NEW JERSEY: Columbia. NEW YORK: Ithaca; Ravana. PENNSYLVANIA: Pavia. TENNESSEE: Gatlinburg. VERMONT: Guilford. WEST VIRGINIA: Falling Waters.

Specimens of *C. cilidolum* examined.—ARKANSAS: London, IX-10-2004 (larvae). CONNECTICUT: Meriden, IX-16-1992 (larvae). ILLINOIS: Highland, IX-8-2004 (larva). INDIANA: Plainville, IX-7-2004 (larva). MARYLAND: Ellicott City, IX-2-2000 (larvae); Kensington, IX-28-2000 (larva); Ridgely, IX-23-1999 (larvae); Wheaton, IX-1-1994 & VIII-11-2000 (larvae). NEW YORK: Ithaca, IX-3-2003 (larvae). VERMONT: Guilford, IX-7-2005 (larvae; 1 ♂, 1 ♀, pupae, em. IV-15 to 28-2006). WEST VIRGINIA: Falling Waters, VI-21-2004 (larvae), X-2005 (larva; 2 ♂, pupae, em. IV-12-2006).

Caryomyia conoidea Gagné, new species

Description.—*Gall* (Figs. 137–138): Occasional, on *Eucarya* hickories; single or in groups, on lower leaf surface between veins; height 3.8–5.0 mm, generally conical, edge at base rounded, base adjacent to leaf uniformly hard, conical and often with cylindrical extension at apex, sides developing longitudinal ridges and furrows upon maturity; green to red or brown surface smooth, with sparse, short, erect, white to tan hairs not obscuring surface; base with central, circular, shallow depression, leaf with short, irregular exfoliation surrounding basal connection to gall; larval chamber basal, depressed-ovoid, lined with yellowish membrane, contrasting with brown to purple, large-celled, spongy, viscous tissue surrounding larval chamber that shrivels with age and traversed by bundle of fibers between larval chamber and gall apex. This gall is most similar to that of *C. sanguinolenta*, q.v. for remarks.

Adult (Fig. 183–185): **Head:** Antenna with 12 flagellomeres; male flagellomeres scarcely bimodal (as in Fig. 237), only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 3 to 4 segmented. **Thorax:** Wing length

2.2–2.7 mm in male (n=5); 3.1–3.5 mm in female (n=5). **Male abdomen:** Third through seventh tergites each with posterior setae continuous across width, in mostly single row; eighth tergite with several posterolateral setae. Genitalia (as in Figs. 247–248): hypoproct broadest near apex, slightly concave posteromedially, margin setose except in concavity, dorsal setulae only on distal third; aedeagus furrowed apically and ventrally. Gonostylius broad at apex. **Female abdomen** (Figs. 183–185): Third through seventh tergites each with posterior setae continuous across width, in mostly single row, usually double at lateral limits; eighth tergite not less sclerotized than seventh and posterior row of setae in mostly single row but double laterally. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 1.8–2.8 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 312) with long, nearly parallel sided, apically notched tooth and long shaft. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded verrucae extensively covering dorsum and with horizontal rows of spicules on venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Length 1.0–1.4 mm (n=5). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, left specimen of two on slide, from gall on *C. glabra*, Wheaton Park, Montgomery Co., Maryland, X-12-1997, R.J. Gagné, deposited in USNM.

Etymology.—The name *conoidea* is a Latin adjective referring to the conical shape of the gall.

Affinities.—See under *C. sanguinolenta*, from which this species differs in the shape of the gall.

Biological note.—In spring the pupa emerges from the base of the gall (as in Fig. 136).

Collections of galls.—CONNECTICUT: Amston (*ovata*); Danbury (*ovata*); Hartland (*ovata*); Harwinton (*ovata*); Litchfield (*ovata*); Meriden (*glabra*); New Haven (*glabra*); Oakville (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Thomaston (*ovata*); Westchester (*ovata*). KENTUCKY: Grayson Lake St. Pk, Carter Co. (*tomentosa*); Winchester (*laciniosa*). MAINE: Eliot (*tomentosa*); North Berwick (*ovata*). MARYLAND: Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*tomentosa*); Wheaton (*glabra*). MASSACHUSETTS: Holyoke (*ovata*); Leominster (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); Wrentham (*ovata*). NEW HAMPSHIRE: Barrington (*ovata*); Dover (*ovata*); Exeter (*ovata*). NEW YORK: E. Schodack (*Carya* sp.); Herkimer (*ovata*); Ithaca (*ovata*); Ravenna (*glabra*, *ovata*). NORTH CAROLINA: Kannapolis (*glabra*). OHIO: Hocking St. For., Hocking Co. (*ovata*). ONTARIO: Dundas (*ovata*). PENNSYLVANIA: Julian (*glabra*); Pavia (*ovata*); Schellsburg (*ovata*). WASHINGTON, DC: National Arboretum (*glabra*). WEST VIRGINIA: Cooper's Rock St. Pk, Preston Co. (*glabra*); 6 mi. NW Hedgesville (*tomentosa*).

Specimens of *C. conoidea* examined.—CONNECTICUT: Amston, IX-19-1994 (larvae); Hartland, IX-7-2005 (larvae; 5 ♂, 3 ♀, pupae, em. IV-15 to 28-2006); Harwinton, IX-6-2005 (larva); New Haven, IX-19-1994 (larvae); Phoenixville, IX-20-1994 (larvae); Plainfield, VIII-27-1988 (larvae). KENTUCKY: Winchester, IX-22-1995 (larvae). MAINE: North Berwick, IX-21-1994 (larva). MARYLAND: Ellicott City, IX-20-2000 (larva); Gaithersburg, X-4-1994 & VIII-20-2000 (larvae); Wheaton, X-12-1997 (larvae). MASSACHUSETTS: Petersham, IX-6-2000 (2 ♂, ♀, em. IV-2001); Wrentham, IX-20-1994 (larvae). NEW HAMPSHIRE: Barrington, IX-22-1994 (larvae; 10 ♂, 9 ♀, pupae, em. IV-1995); Exeter, IX-21-1994 (larvae). NORTH CAROLINA: Kannapolis, IX-18-2000 (larvae). ONTARIO: Dundas, VIII-17-1994 (larvae). WASHINGTON, DC: National Arboretum, X-28-2002 (larvae; 4 ♂, 5 ♀, pupae, em. IV-2003). WEST VIRGINIA: 6 mi. NW Hedgesville, X-1-1995 & VIII-8-2000 (larvae).

Caryomyia cucurbitata Gagné, new species

Description.—*Gall* (Figs. 149-151): Infrequent, on *Eucarya* hickories; on lower leaf surface, single or in row along major vein; length 3.0-5.0 mm, spheroidal at base, abruptly narrowed to slender

neck of variable length, digitate at apex; yellow with spherical, red, resinous dots and sparse long or short white hair not obscuring surface, the neck brown or black, with white hairs; base with circular, shallow, central excavation; larval chamber basal, ovoid, white, surrounded by green tissue turning brown and woody; a bundle of fibers present between larval chamber and gall apex. The gall shows some similarity with that of *C. ansericollum* but the latter is not covered with resinous dots and occurs only on bitternut. Also generally close in shape is the gall of *C. echinata* but the latter is covered with long, stiff, straight hairs and occurs on the leaf lamina rather than the vein.

Adult: unknown.

Pupa (Figs. as for 213-214): Antennal bases pyramidal, moderately separated, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.7-2.5 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 308) with long, nearly parallel-sided, apically-notched tooth and long shaft, widest anteriorly, tapered beyond. Papillae without setae, bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded verrucae covering dorsum at midlength and horizontal rows of spicules on venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Length 0.9-1.1 mm (n=7). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype:* Third instar, from gall on *C. tomentosa*, Lusby, Maryland, IX-16-2003, R.J. Gagné, deposited in USNM.

Etymology.—The name *cucurbitata*, a Latin adjective meaning pumpkin-like, refers to the general resemblance of the gall to a pumpkin.

Affinities.—See discussion under *C. inclinata*.

Collections of galls.—ALABAMA: Auburn (*tomentosa*); Greenville (*tomentosa*). ARKANSAS: Chester (*texana*). KENTUCKY: Brownsville (*tomen-*

tosa); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*, *tomentosa*). MARYLAND: Beltsville, USDA Agricultural Research Center (*tomentosa*); Clarksburg (*tomentosa*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*tomentosa*); Ridgely (*tomentosa*). MISSOURI: St. Clair (*tomentosa*). NORTH CAROLINA: Alamance (*tomentosa*). OHIO: Hocking St. For., Hocking Co. (*tomentosa*). TENNESSEE: Mohawk (*tomentosa*). WEST VIRGINIA: 6 mi NW Hedgesville (*ovata*).

Specimens examined.—ALABAMA: Auburn, IX-19–2000 (larvae); Greenville, IX-20–2000 (larvae). ARKANSAS: Chester, IX-9–2004 (larvae). KENTUCKY: Brownsville, IX-21–1995 (larvae). MARYLAND: Beltsville, USDA Agricultural Research Center, V-5–1994 & VIII-31–2004 (larvae); Clarksburg, X-4–2005 (larvae; pupa excised from gall III-28–2006); Gaithersburg, X-4–1994 (larvae); Lusby, IX-16–2003 (larvae); Ridgely, IX-23–1999 (larvae). MISSOURI: St. Clair, IX-8–2004 (larva). NORTH CAROLINA: Alamance, IX-18–2000 (larvae). OHIO: Hocking St. For., Hocking Co., IX-19–1995 (larvae). TENNESSEE: Mohawk, IX-12–2004 (larvae). WEST VIRGINIA: 6 mi NW Hedgesville, VIII-27–2000 (larvae).

Caryomyia cynipsea (Osten Sacken)

Cecidomyia cynipsea Osten Sacken 1862: 193; Felt 1918: 47 (*Caryomyia*); Gagné 2004: 276, as unplaced sp. of Cecidomyiinae.

Description.—*Gall* (Figs. 162–164): Rare, on *Eucarya* hickories; on lower leaf surface, along midrib; 2.6–5.0 mm in height, irregularly spheroid, smooth, hairless, yellow turning brown; base with irregular, shallow, central excavation; woody, polythalamous, with numerous, discrete, irregularly ovoid, smooth walled, larval chambers. This is the only polythalamous gall formed by a *Caryomyia*. Some other species, e.g., *C. aggregata*, may appear to be so because their galls will occasionally be found so crowded as to be partially fused, but below each larval chamber will be a basal connection to the leaf. The gall of *C. cynipsea* has a single connection to the vein.

Adult (female only): Head: Antenna with 12 flagellomeres; female flagellomeres mostly with 2 horizontal circumfila connected by 2 vertical strands. the basal circumfilum on the 2 basal flagellomeres doubled. Labella separated from one another, rounded anteriorly, hemispherical, short-setulose, without setae. Palpus 4 segmented. Thorax:

Wing length 3.6 mm in female (n=1). Female abdomen: Third through eighth tergites usually with posterior setae in 2–3 lateral rows, sometimes almost joined mesally, especially on posterior segments, setae not as long or strong on eighth as on previous tergite. Ninth segment (Fig. 264) broad, pliable except for slender dorsal sclerite, setae shorter than cerci, in separate dorsolateral and ventral groups. Cerci elongate-ovoid in lateral view, fused dorsally on basal third.

Pupa (as for Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 2.2–3.7 mm (n=7). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 311) with elongate, parallel-sided, apically notched tooth and strong shaft. Papillae without setae, their bases not raised. Lateral papillae 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments extensively covered with verrucae mesodorsally and antero- and posteroventrally. Terminal segment shorter than eighth. Second instar: Not seen.

Type material.—Syntypes: galls and larva, from *Carya* sp., vic. Washington, DC, July, Osten Sacken, evidently lost. No examples exist in either the MCZ or the USNM. Neotype designated here: third instar (middle of 5 specimens on slide), from gall on *C. glabra*, Wheaton Park, Wheaton, Maryland, VIII-7-1985, R.J. Gagné, deposited in USNM.

Affinities.—This species forms the only polythalamous gall in the genus. The female is distinctive for its short, deep ovipositor with short setae.

Biological notes.—In Spencerville, MD, on July 7, 2004, two separate young galls were found, each containing many first instars in discrete chambers, showing that the gall is truly polythalamous (Fig. 162). Third instars were found in galls from the same site the same year in mid-September. The following spring 3 females were reared, all emerging from separate exit holes from one of the galls.

Collections of galls.—GEORGIA: Forsyth (*glabra*, *ovata*). MARYLAND: Wheaton (*glabra*); Gaithersburg (*tomentosa*); Spencerville (*tomentosa*).

Specimens of *C. cynipsea* examined.—GEORGIA: Forsyth, IX-22–2000 (larvae). MARYLAND: Gaith-

ersburg, X-4-1994 (larvae); Spencerville, IX-20-2004 (larvae; 3 ♀, pupae, em. IV-2-2004); Wheaton, VIII-7-1985 (larvae).

Caryomyia deflexipili Gagné, new species

Description.—**Gall** (Figs. 66-67): Occasional, on *Eucarya* hickories, but not east of the Appalachians, except for New England and on the Georgia Piedmont; single or dispersed, on lower leaf surface between veins; 2.8-3.7 mm in height, spherical with small umbo at apex; green, becoming tan to brown, surface matte, non-sticky, with short, sparse, white, decumbent hairs not obscuring surface; base with small conical pedicel, leaf irregularly exfoliate surrounding base of gall; wall firm, brittle, uniformly thin, enclosing glabrous, longitudinally ridged larval chamber of same shape as gall. This gall is most similar to that of *C. glauciglobus* (Fig. 68), which, instead of having a sparse covering of deflexed hairs, is naked and covered with a bluish bloom.

Adult: **Head:** Antenna with 18-21 flagellomeres in male, 19-20 in female; each of the male flagellomeres (as in Fig. 237) scarcely binodal, area between nodes marked mainly by lack of setulae and slight compression between basal and middle circumfila, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 2.3-2.4 mm in male (n=2); 2.8-3.3 mm in female (n=2). **Male abdomen:** Third through seventh tergites each with posterior setae in 3-4 rows laterally, narrowing to 1-2 mesally; eighth tergite without posterior setae. Genitalia: hypoproct broadest before posterior convex margin, margin setose, dorsally with setulae only on apical fourth; aedeagus evenly cylindrical, wide, notched apically. **Female abdomen:** Third through seventh tergites as for male; eighth tergite not so strongly sclerotized as preceding tergite, with few posterior setae, the setae not as long as on seventh tergite. Ninth segment pliable except for slender dorsal sclerite that widens apically to invest part of cerci, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally, mostly shorter than lateral setae. Cerci elongate-ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 203-204): Antennal bases oblique in ventral view, converging and narrow-

ing anteriorly, their narrowly rounded apices closely adjacent. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar** (Figs. 226-228): Length 1.7-3.4 mm (n=6). Body elongate-fusiform, broad and knobby anteriorly, strongly tapered posteriorly. Head directed ventrally. Spatula (Fig. 298) with parallel-sided, deeply notched anterior tooth and parallel-sided shaft not appreciably wider than tooth. Papillae without setae, their bases prominently raised, especially those of dorsal, pleural, and terminal papillae. Lateral papillae 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments completely covered by verrucae. Terminal segment tapered to narrow terminus, prolonged beyond the ventrally disposed terminal papillae, appreciably longer than eighth segment. **Second instar:** Length 0.9-1.4 mm (n=8). Collar segment with patch of enlarged spicules on each side. Spatula with apically pointed tooth and longer, wider shaft. Bases of dorsal and pleural papillae raised but asetose. Six dorsal papillae on first 7 abdominal segments. Collar segment with enlarged group of spicules anterolaterally. Spatula with rectangular shaft and large pointed tooth. Dorsal and pleural papillae with short setae, their bases raised.

Type material.—**Holotype:** Third instar (middle of 3 larvae on slide), from gall on *C. ovata*, Amston, Connecticut, IX-17-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *deflexipili* is a noun formed from the Latin *deflexus* (decumbent) and *pilus* (fine hair) with reference to the fine decumbent hair on the gall surface.

Affinities.—This species is remarkable and unique in the genus for having an augmented number, 18 or more, of antennal flagellomeres. In many ways it is most like *C. glauciglobus*, but adults have not yet been reared for the latter species. Both have similarly-shaped galls but with distinctively different surfaces, that of the present species with short, decumbent hairs, that of *C. glauciglobus* without hairs and glaucous. Larvae of both are generally similar, particularly for their ventrally-directed heads, fusiform shape, and very long terminal segment. The two differ in the shape of the spatula.

Biological notes.—Pupae exit from the side of the gall in April and May after winter diapause.

Collections of galls.—**ARKANSAS:** Chester (*texana*); Palestine (*ovata*); Winslow (*ovata*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Hartland (*ovata*); Harwinton (*ovata*); Hopeville (*ovata*); Litchfield (*ovata*); Meriden (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Thomaston (*ovata*). **GEORGIA:** 8 km E Fort Valley (*pallida*); Lizella (*ovata*). **ILLINOIS:** Dexter (*laciniosa*); Highland (*laciniosa*); Marshall (*tomentosa*). **INDIANA:** Richmond (*tomentosa*); Spencer Co. (*ovata*). **KENTUCKY:** Winchester (*laciniosa*). **MAINE:** Eliot (*tomentosa*); North Berwick (*ovata*). **MASSACHUSETTS:** Great Barrington (*ovata*); Holyoke (*ovata*). **MISSISSIPPI:** Noxubee Natl Wildlife Ref. (*ovata*). **MISSOURI:** Rolla (*texana*); Wildwood (*tomentosa*). **NEW HAMPSHIRE:** Barrington (*ovata*); Exeter (*ovata*); Greenland (*ovata*); Seabrook (*ovata*). **NEW JERSEY:** Columbia (*ovata*). **NEW YORK:** Herkimer (*ovata*); Ithaca (*ovata*); Ravenna (*glabra*, *ovata*); Saratoga Springs (*ovata*). **OHIO:** Hocking St. For., Hocking Co. (*ovata*); St. Clairsville ((*tomentosa*); Summerford (*tomentosa*). **PENNSYLVANIA:** Kirby (*ovata*); Mooresville (*tomentosa*); Schellsburg (*ovata*). **TENNESSEE:** Gatlinburg (*ovata*); Jackson (*tomentosa*). **WEST VIRGINIA:** Cacapon (*ovata*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. deflexipili* examined.—**CONNECTICUT:** Amston, IX-17-1999 (larvae); Hartland, IX-7-2005 (larvae; pupal exuviae, 1 ♂, 7 ♀, em. IV-15 to V-2-2006); Phoenixville, IX-20-1994 (larvae). **GEORGIA:** Lizella, X-12-1993, J. & R. Payne (larvae). **INDIANA:** Spencer Co., IX-20-1995 (larvae). **KENTUCKY:** Winchester, IX-22-1995 (larvae). **MAINE:** North Berwick, IX-22-1994 (larvae). **NEW HAMPSHIRE:** Barrington, IX-22-1994 (larvae); Exeter, IX-21-1994 (larvae). **NEW YORK:** Saratoga Springs, IX-25-1994 (larvae). **OHIO:** Hocking St. For., Hocking Co., IX-19-1995 (larvae). **WEST VIRGINIA:** 6 mi NW Hedgesville, IX-4-19- to X-17-1999 & VII-26-2000 (larvae), & X-2000 (larvae; 2 ♂, 2 ♀, em. IV-2001).

Caryomyia echinata Gagné, new species

Gall (Figs. 14, 152–153): Rare, on *Eucarya* hickories west of the Appalachian Mts; on lower leaf surface, between veins; length 2.4–5.0 mm, spheroidal at base, tapering abruptly to long, narrow neck, 2–4 parted apically; covered with long, stiff, brown hairs mixed with short, soft brown hairs, surface obscured; base with circular, shallow, central depression; larval chamber basal, ovoid, white to violet, remainder of gall made up of

green tissue turning brown and woody; a bundle of fibers present between larval chamber and gall apex. See under *C. inclinata* for similar species. This gall is the only woody *Caryomyia* gall that is covered with very long, stiff hairs and occurs between instead of on veins.

Adult and pupa: Unknown.

Larva: **Third instar:** Length 1.7–2.2 mm (n=6). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 315) with long, nearly parallel-sided, apically-notched tooth and long shaft. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded and pointed verrucae covering dorsum across midlength and horizontal rows of pointed spicules across venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Not seen.

Type material.—*Holotype:* Third instar, from gall on *C. texana*, Rolla, Missouri, IX-8-2004, R.J. Gagné, deposited in USNM.

Etymology.—The name *echinata* is a Latin adjective meaning spiny, with reference to the long, stiff hairs covering the gall.

Affinities.—See discussion under *C. inclinata*.

Collections of galls.—**ARKANSAS:** Beulah (*tomentosa*); 2 mi S DeQueen (*tomentosa*); Rt.1 at Red River, Little River Co. (*tomentosa*). **ILLINOIS:** Marshall (*tomentosa*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 193, Choctaw Co. (*pallida*, *tomentosa*); Noxubee Natl Wildlife Ref., Oktibbeha Co. (*ovata*); 7 mi E Starkville (*pallida*). **MISSOURI:** Conway (*ovata*); Rolla (*texana*). **OHIO:** Gypsum (*ovata*, Wells 1916: Fig. 14); Summerford (*tomentosa*). **ONTARIO:** Dundas (*ovata*). **TEXAS:** Daingerfield St. Pk, Morris Co. (*tomentosa*).

Specimens of *C. echinata* examined.—**ARKANSAS:** Beulah, IX-10-2004 (larvae). **MISSOURI:** Rolla, IX-8-2004 (larva). **OHIO:** Summerford, IX-6-2004 (larvae).

Caryomyia eumaris Gagné, new species

Description.—Gall (Figs. 9a, 88–89): Common, found on *Eucarya* hickories; usually single or scattered, attached to small veins on lower leaf surface; 2.2–2.7 mm in length, recumbent, subovoid except for apical, curved, tapered extension; rough textured, white, green, to tan, with short,

sparse, white hairs not obscuring surface; base of gall with short, central conical projection surrounded by shallow, circular indentation; wall firm, brittle, uniformly thin, larval chamber glabrous with longitudinal ridges following gall axis from leaf vein connection to recurved apex. This gall is most similar to that of *C. recurvata* but has a rough surface with sparse hair. The gall of *C. recurvata* has a hairless, smooth, glaucous surface.

Adult (female only): Head: Antenna with 12 flagellomeres, flagellomeres with 2 horizontal circumfila connected by 2 vertical strands (as in Fig. 238). Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4 segmented. **Thorax:** Wing length 1.8–1.9 mm (n=2). **Abdomen:** Third through seventh tergites each with single posterior row of setae continuous across width, eighth tergite without setae. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 1.2–1.7 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 291) with tooth nearly parallel-sided, usually narrowed toward apex, notched at apex, the shaft wide anteriorly, narrowed beyond. Papillae without setae, their bases not raised. Lateral papillae 2–3 on each side of spatula. Only 4 dorsal papillae present on first 7 abdominal segments. Abdomen with small field of verrucae at midlength of dorsum, usually only around the 2 lateralmost pairs of dorsal setae, but occasionally more extensive, and with horizontal rows of spicules present on venter anterior to sternal papillae and a few rows of spicules along posterior margin. Terminal segment shorter than eighth. **Second instar:** Length 0.7–0.8 (2). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae asetose. Only 4 dorsal papillae present on first 7 abdominal segments.

Type material.—**Holotype:** Third instar, from gall on *C. tomentosa*, Entomology Road, BARC, Beltsville, Maryland, IX-26-1993, R.J. Gagné, deposited in USNM.

Etymology.—The name *eumaris* is a Greek noun for Persian shoe, with reference to the recumbent gall's upturned apex.

Affinities.—Galls of several other species, *C. procumbens*, *C. recurvata*, *C. spinulosa*, and *C. supina*, have similar attachments to leaf veins, grow horizontally, are thin-walled but brittle, and have longitudinally ridged larval chambers. Larvae of all are generally similar with narrow but two-toothed spatulas and only four dorsal papillae on each abdominal segment. The adult stage has been reared for only two species of this group, the female for *C. eumaris* and the male for *C. recurvata*.

Biological notes.—In mid-June in central Maryland, galls are small to full-grown, green and soft, and contain first instars. By end of June through August, most galls examined contained second instars but a few still had first instars. By end of August galls mostly contained third instars and many galls were turning or had turned red.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*ovata, tomentosa*); Greenville (*tomentosa*). **ARKANSAS:** Beulah (*tomentosa*); 2 mi S DeQueen (*tomentosa*); 3 mi S Harrison (*tomentosa*); Osage (*tomentosa*). **CONNECTICUT:** Oakville (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Southbury (*tomentosa*); Westchester (*ovata*). **FLORIDA:** Chattahoochee (*tomentosa*); Gainesville (*tomentosa*); Ponce de Leon (*glabra*). **GEORGIA:** Lizella (*ovata, tomentosa*). **ILLINOIS:** Dexter (*laciniosa, tomentosa*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson Lake St. Pk, Carter Co. (*ovata*); Winchester (*glabra*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Brighton (*tomentosa*); Calverton (*tomentosa*); Clarksburg (*glabra, tomentosa*); College Park (*glabra*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*tomentosa*); Potomac (*tomentosa*); Ridgely (*glabra, tomentosa*); Silver Spring (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*tomentosa*). **MASSACHUSETTS:** Merrimac (*ovata*). **MISSISSIPPI:** Noxubee Natl Wildlife Ref., Oktibeha Co. (*tomentosa*); 7 mi E Starkville (*tomentosa*). **MISSOURI:** Holly Ridge State For., Stoddard Co. (*tomentosa*); Conway (*ovata*). **NEW YORK:** Ravena (*ovata*). **NORTH CAROLINA:** Alamance (*tomentosa*);

Fayetteville (*tomentosa*); Providence (*tomentosa*); Rowland (*tomentosa*). OHIO: Hocking Co. (*ovata*, Wells 1916: Fig. 9a). OKLAHOMA: Sallisaw (*tomentosa*). SOUTH CAROLINA: Georgetown (*tomentosa*). TENNESSEE: Crossville (*pallida*, *tomentosa*); Dandridge (*tomentosa*); Greene Co., I 81, Mile 38.5 (*tomentosa*); Mohawk (*tomentosa*). TEXAS: Daingerfield St. Pk, Morris Co. (*tomentosa*). VIRGINIA: Carson (*tomentosa*); Dinwiddie (*tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); Radford (*tomentosa*); Skippers (*tomentosa*). WASHINGTON, DC: National Arboretum (*glabra*, *tomentosa*); Walter Reed Army Medical Center (*tomentosa*).

Specimens of *C. eumaris* examined.—ARKANSAS: Osage, IX-9-2004 (larva). CONNECTICUT: Phoenixville, IX-20-1994 (larvae). KENTUCKY: Brownsville, X-21-1995 (larvae); Grayson Lake St. Pk, Carter Co., IX-22-1995 (larvae); Winchester, IX-22-1995 (larvae). MARYLAND: Beltsville, USDA Agricultural Research Center, IX-26-1993 (larvae), IX-23-2005 (pupal exuviae, 3 ♀, em. IV-10-2006); Ridgely, X-1999 (larvae; 2 ♀, pupa, em. IV-2000), X-6-2005 (larvae); Silver Spring, IX-17-1993 (larvae). SOUTH CAROLINA: Georgetown, X-1-2005, D. & B. Gagné (larvae).

Caryomyia flaticrustum Gagné, new species

Description.—*Gall* (Figs. 16a, 78–81): Common, on *Eucarya* hickories; on lower leaf surface between veins, usually clustered; 2–4 mm in height, usually longer than wide, conical to cylindrical, deeply concave apically, walls encircling concavity flared outwards, cylindrical, or ingrown toward apex as to form nearly complete false chamber, base of concavity with short central umbo; green at first, drying to tan or brown, walls surrounding concavity soft, eventually turning mucilaginous and contracting to form circular brown crust atop basal portion of gall; leaf with only slight exfoliation surrounding conical base of gall; lateral wall of larval chamber firm, brittle, thin apical wall usually thicker, larval chamber glabrous, with longitudinal ridges. When dried this gall simulates that of *C. melicrustum* but the gall of the latter is surrounded basally with an extensive, thick leaf exfoliation.

Adult: **Head:** Antenna with 12 flagellomeres; male flagellomeres (as in Fig. 237) scarcely binodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in

length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose or asetose, setulose. Palpus 4 segmented. **Thorax:** Wing length 1.6–2.0 mm in male (n=5); 1.4–2.2 mm in female (n=5). **Male abdomen:** Third through seventh tergites each with posterior setae in single row, continuous across width; eighth tergite without posterior setae. Genitalia (as in Figs. 247–248): gonostylus tooth nearly as wide as gonostylus; hypoproct broadest near apex, concave posteromedially, margin setose except in concavity; setulose dorsally only on distal third; aedeagus furrowed apically and ventrally. **Female abdomen:** Third through seventh tergites each with single row of posterior setae, continuous across width; eighth tergite without posterior setae. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.8–2.2 mm (n=6). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 289) with anterior tooth narrowing from base to slightly notched or erose apex, shaft wide anteriorly, tapering abruptly and linear beyond. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments essentially smooth dorsally, occasionally with some verrucae around lateral pairs of dorsal papillae, with fine, pointed spicules on venter anterior to sternal papillae and without spicules posteriorly. Terminal segment shorter than eighth. **Second instar:** Length 0.6–0.9 mm (n=5). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—**Holotype:** Specimen on left of two on slide, third instar, from gall on *C. tomen-*

tosa, BARC, Beltsville, Maryland, IX-30-2003, R.J. Gagné, deposited in USNM.

Etymology.—The name *flaticrustum*, a noun, is formed from the Latin *flatus* for puff of air and *crustum* for tart, with reference to the ephemeral apical funnel-like ring of tissue that shrinks atop the tart-like base of the gall.

Affinities.—*Caryomyia flaticrustum*, *C. levicrustum*, *C. melicrustum*, and *C. striolacrustum* are four common, widely distributed species on the *Eucarya* section with diminutive, more or less discoid galls with conical bases (Figs. 78–87). The main differences among the four species are in the shape and surface texture of the galls. That of *C. flaticrustum*, has a soft, sticky, concave apex that eventually contracts to form a thick crust. These mature galls simulate somewhat galls of *C. melicrustum*, except that galls of the latter are subtended by a definite exfoliation of the leaf. Larvae of all four species are generally similar with a fairly smooth integument and cruciform spatula. The spatula tooth is barely notched in three species, but acutely pointed in *C. levicrustum*.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*ovata, tomentosa*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata, pallida*). **ARKANSAS:** Beulah (*tomentosa*); Chester (*texana*); 2 mi S DeQueen (*texana, tomentosa*); 3 mi S Harrison (*tomentosa*); London (*tomentosa*); Magazine Mt., Logan Co. (*ovata, texana, tomentosa*); Osage (*texana, tomentosa*); Palestine (*ovata, tomentosa*); Piney (*texana*); Rt. 1 at Red River, Little River Co. (*tomentosa*). **CONNECTICUT:** Amston (*ovata*); Meriden (*glabra, ovata*); New Haven (*glabra*); Phoenixville (*ovata*); Plainfield (*ovata*); Southbury (*glabra, tomentosa*); Westchester (*ovata*). **FLORIDA:** Ponce de Leon (*glabra*). **GEORGIA:** Carnesville (*glabra*); 8 km E Fort Valley (*pallida*); Forsyth (*glabra, ovata*); Lizella (*ovata, tomentosa*). **ILLINOIS:** Dexter (*laciniosa, tomentosa*); Marshall (*tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson Lake St. Pk, Carter Co. (*tomentosa*); Morehead (*tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Pennyroyal St. Pk, Christian Co. (*glabra, ovata*); Winchester (*laciniosa*). **MAINE:** North Berwick (*ovata*). **MARYLAND:** Beaver Dam (*tomentosa*); Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Brighton (*tomentosa*); Calverton (*tomentosa*); Clarksburg (*glabra, tomentosa*); College Park (*glabra*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*glabra, tomentosa*); Piney Grove (*ovata*); Potomac (*tomen-*

tosa); Ridgely (*glabra, tomentosa*); Silver Spring (*glabra, tomentosa*); Snow Hill (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra, tomentosa*). **MASSACHUSETTS:** Great Barrington (*ovata*); Holyoke (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); Wrentham (*ovata*). **MISSOURI:** Conway (*ovata, texana*); Crowley Ridge Roadside Pk, Stoddard Co. (*glabra, tomentosa*); Holly Ridge State For., Stoddard Co. (*glabra, tomentosa*); Rolla (*texana*); Wildwood (*tomentosa*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 193, Choctaw Co. (*glabra, pallida, tomentosa*); Noxubee Natl Wildlife Ref., Oktibbeha Co. (*ovata, tomentosa*); nr. Sessums, Oktibbeha Co. (*ovata*); 7 mi E Starkville (*pallida*). **MISSOURI:** St. Clair (*tomentosa*). **NEW HAMPSHIRE:** Barrington (*ovata*); Dover (*ovata*); Kingston (*ovata*). **NEW JERSEY:** Columbia (*ovata*); Nyack (*tomentosa*); Columbia (*tomentosa*). **NEW YORK:** Ithaca (*ovata*); Saratoga Springs (*ovata*). **NORTH CAROLINA:** Alamance (*tomentosa*); Alberta (*glabra*); Dorchest (tomentosa); Fayetteville (*tomentosa*); Gastonia (*tomentosa*); Providence (*glabra, tomentosa*); Rowland (*tomentosa*); Wise (*tomentosa*). **OHIO:** Hocking St. For., Hocking Co. (*tomentosa*); Hocking Co. (*Carya* sp., Wells 1916: Fig. 16a); St. Clairsville (*tomentosa*). **OKLAHOMA:** Sallisaw (*tomentosa*). **PENNSYLVANIA:** Pavia (*ovata*); Schellsburg (*glabra*). **SOUTH CAROLINA:** Georgetown (*tomentosa*); Richland Co. **TENNESSEE:** Crossville (*pallida*); Dandridge (*tomentosa*); Dickson (*tomentosa*); Gatlinburg (*glabra, tomentosa*); Greene Co., I 81, Mile 38.5 (*ovata, tomentosa*); Jackson (*tomentosa*); Lebanon (*glabra*); Mohawk (*tomentosa*). **TEXAS:** Daingerfield St. Pk, Morris Co. (*tomentosa*). **VIRGINIA:** Warren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*); Carson (*tomentosa*); Dinwiddie (*glabra, tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); Rt. 81, mi. 13.9, Washington Co. (*ovata*). **WASHINGTON, DC:** National Arboretum (*glabra, tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); Cooper's Rock St. Pk, Preston Co. (*glabra*); 6 mi. NW Hedgesville (*tomentosa*).

Specimens of *C. flaticrustum* examined.—**ILLINOIS:** Dexter, X-8-2004 (larvae; 3 ♀, em. IV-11-2005). **MARYLAND:** Beltsville, USDA Agricultural Research Center, IX-8-2002 (larvae; 5 ♂, 2 ♀, pupae, em IV-2003) & IX-30-2003 (larvae; 3 ♂, 3 ♀, pupae, em IV-11-2004); College Park, IX-23-2003 (larvae; 2 ♂, 2 ♀, pupae, em. IV-11-2004); Ridgely, IX-2-2000 (larvae; 3 ♂, 2 ♀, em. IV-2001), IX-11-2003 (larvae). **NORTH CAROLINA:** Providence,

IX-18-2000 (larvae). **TEXAS:** New Waverly, X-6-2001 (larvae).

Caryomyia glauciglobus Gagné, new species

Description.—*Gall* (Figs. 68–69): Occasional, on *Eucarya* hickories; single or dispersed on lower leaf surface, between veins; 3.6–4.2 mm in height, spherical with small umbo at apex, green becoming tan to brown, smooth, not sticky, hairless, covered with blue-gray powdery bloom; base with small conical pedicel, leaf with irregular exfoliation around base of gall; wall firm, brittle, uniformly thin, larval chamber glabrous with longitudinal ridges. This gall appears superficially similar to those of *C. deflexipili* and *C. caryaee* because of their spherical shape without conspicuous hairs. Galls of *C. deflexipili* have deflexed, fine hair that is detectable with a hand lens, while galls of *C. caryaee* are sticky to the touch and not glaucous.

Adult and pupa: Unknown.

Larva: Third instar: Length 3.2–4.5 mm (n=6). Body elongate-fusiform, broad and knobby anteriorly, strongly tapered posteriorly. Head directed ventrally. Spatula (Fig. 299) with parallel-sided, deeply notched anterior tooth and parallel-sided shaft not appreciably wider than tooth. Papillae without setae, their bases prominently raised, especially those of dorsal, pleural, and terminal papillae. Lateral papillae 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments completely covered by verrucae. Terminal segment tapered to narrow terminus, prolonged beyond the ventrally disposed terminal papillae, appreciably longer than eighth segment. *Second instar:* Not seen.

Type material.—*Holotype:* Third instar, from gall on *C. ovata*, Amston, Connecticut, IX-7-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *glauciglobus* is a noun formed from the Latin *glaucus* (bluish gray) and *globus* (globe), referring to the blue-powdery, spherical gall.

Affinities.—See under *C. deflexipili*.

Collections of galls.—**CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Litchfield (*ovata*); Meriden (*ovata*); Phoenixville (*ovata*). **GEORGIA:** Forsyth (*glabra*); Lizella (*tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Winchester (*laciniosa*). **MAINE:** North Berwick (*ovata*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*).

MASSACHUSETTS: Magnolia (*Carya sp.*); Petersham (*ovata*); Wrentham (*ovata*). **MISSISSIPPI:** nr. Sessums, Oktibbeha Co. (*ovata*). **NEW YORK:** Herkimer (*ovata*); Ithaca (*ovata*). **NEW YORK:** Albany (*Carya sp.*); Orchard Park (*Carya sp.*); Ravena (*ovata*). **OHIO:** Hocking St. For., Hocking Co. (*tomentosa*); St. Clairsville (*tomentosa*). **TENNESSEE:** Jackson (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*ovata*); Cacapon (*ovata*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. glauciglobus* examined.—**CONNECTICUT:** Amston, IX-17-1999 (larva); Danbury, IX-6-2005 (larvae). **KENTUCKY:** Winchester, IX-22-1995 (larva). **MAINE:** North Berwick, IX-21-1995 (larvae). **MASSACHUSETTS:** Petersham, IX-7-2000 (larvae). **NEW YORK:** Ithaca, IX-3-2003 (larva). **OHIO:** Hocking St. For., Hocking Co., IX-19-1995 (larvae). **TENNESSEE:** Jackson, IX-11-2004 (larva). **WEST VIRGINIA:** 6 mi NW Hedgesville, VI-25-2004 (larvae).

Caryomyia glebosa Gagné, new species

Description.—*Gall* (Figs. 130–131): Rare but widespread, on *Eucarya* hickories; on lower leaf surface on vein; 3.0–3.2 mm in height, conical, hairless, brown to blood-red, bumpy, the bumps sometimes yellow; base with narrow, circular, shallow, central excavation; larval chamber basal, ovoid, lined with yellowish pellicle, remainder of gall tissue large-celled, blood-red, viscous, traversed between larval chamber and apex of gall by bundle of long fibers. The gall of this species is the only soft, conical *Caryomyia* gall that is hairless and covered with bumps.

Adult and pupa: Unknown.

Larva: Third instar (Figs. 223–225): Length 1.7–2.2 mm (n=6). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 307) with long, nearly parallel-sided, apically-notched tooth and long shaft widest just posterior to tooth, parallel-sided beyond. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded verrucae covering dorsum at midlength and horizontal rows of spicules on venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. *Second instar:* Length 0.8–1.5 mm (n=6). Collar segment with patch of enlarged spicules on each side. Spatula

with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, setose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. tomentosa*, Wildwood, Missouri, IX-8-2004, R.J. Gagné, deposited in USNM.

Etymology.—The name *glebosa* is an adjective from the Latin meaning bumpy and refers to the characteristic surface on the gall of this species.

Affinities.—Galls of this species resemble somewhat those of *C. turbanella* because of the conical shape and at least partly bumpy surface. Larvae of the two species are similar, but adults of *C. glebosa* are not yet known.

Collections of galls.—ARKANSAS: 3 mi S Harrison (*tomentosa*). CONNECTICUT: Meriden (*ovata*); Phoenixville (*ovata*). ILLINOIS: Marshall (*tomentosa*). MARYLAND: Kemp Mill (*glabra*); Gaithersburg (*tomentosa*); Silver Spring (*glabra*); Spencerville (*tomentosa*). MISSOURI: Wildwood (*tomentosa*). NORTH CAROLINA: Wise (*tomentosa*). TENNESSEE: Dandridge (*tomentosa*); Dickson (*tomentosa*). WEST VIRGINIA: Cacapon (*ovata*).

Specimens of *C. glebosa* examined.—ILLINOIS: Marshall, IX-7-2004 (larvae). MARYLAND: Gaithersburg, X-4-1994 (larvae); Silver Spring, IX-22-1993 (larvae); Spencerville IX-21-2003 (larvae). MISSOURI: Wildwood, IX-8-2004 (larvae).

Caryomyia guttata Gagné, new species

Description.—*Gall* (Figs. 154–155): Found commonly but only on the central Florida endemic, scrub hickory, of the *Eucarya* section; on lower leaf surface on vein, occasionally on leaf rachis, usually clustered in a row along major vein and often coalescing in series; 3–6 mm in height, spheroid basally, usually teardrop shaped, the apex tapering to a point; surface rugose, covered with tiny, red-brown and/or gold, resinous dots (as is the tree) and sparse setae; base with circular to irregular, shallow, central excavation; wall woody, thick, larval chamber basal, irregularly ovoid, glabrous, green to brown, a bundle of fibers present between apex of larval chamber and gall apex. This is the only hickory gall with such a local distribution and the only one known to occur sometimes on the leaf rachis. Galls resemble most those of *C. aggregata* and *C. holotricha* in shape but lack a dense covering of long hair and have no intrusion of hairs into the larval chamber.

As are galls of *C. aggregata*, galls of *C. guttata* are found in close series along leaf veins.

Adult and pupa: Unknown.

Larva: Third instar: Length 2.4–3.5 mm (n=6). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 321) with single tooth tapering from wide base to pointed apex and with shaft broad anteriorly and tapering beyond. Papillae without setae. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with dorsum extensively covered with verrucae and venter spiculose anterior to sternal papillae and on posterior third. Terminal segment shorter than eighth. *Second instar:* Not seen.

Type material.—*Holotype*: Third instar, right-most of 3 specimens on slide mount, from gall on *C. floridana*, St. Lucie, Florida, XI-7 to 12-2002, K. Hibbard, deposited in USNM.

Etymology.—The name *guttata* is a Latin adjective meaning speckled, with reference to the resin-flecked surface of the gall.

Affinities.—See discussion under *C. inclinata*.

Collections of galls.—FLORIDA (all on *Carya floridana*): Avon Park; Ft. Pierce; St. Lucie; Vero Beach; White City.

Specimens of *C. guttata* examined.—FLORIDA: Avon Park, XI-7 to 12-2002 (larvae); St. Lucie, XI-7 to 12-2002 (larvae), White City, XI-7 to 12-2002 (larvae).

Caryomyia hirtidolum Gagné, new species

Description.—*Gall* (Figs. 49–50): Occasional, on *Eucarya* hickories; on lower leaf surface, between veins; 3.0–3.9 mm in height, spheroidal, slightly longer than wide, base broadly rounded to truncate in profile, apex with small central nipple surrounded by extensive areola that with pressure can separate from gall; covered with long, silvery brown to brown hair obscuring surface, the hair denser and longer, rosette-like, on areola; base with wide, deep, circular indentation; wall firm, brittle, almost uniformly thin, larval chamber glabrous, with longitudinal ridges. For notes on galls of related species, see under *C. cilidolum*.

Adult and pupa: Unknown.

Larva: Third instar: Length 2.8–3.8 mm (n=10). Body dorsoventrally flattened, elongate-ovoid, broadly rounded anteriorly, spindleform posteriorly. Head directed ventrally, surmounted dor-

sally by collar segment. Spatula (Fig. 278) with pointed anterior tooth and long, broad shaft. Papillae without setae, their bases raised. Lateral papillae 2 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Body covered with verrucae. Terminal segment as long as eighth, rounded posteriorly. **Second instar:** Length 1.2 mm (n=1). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Six dorsal papillae on first 7 abdominal segments. Bases of dorsal and pleural papillae elongate, setose.

Type material.—**Holotype:** Third instar, from gall on *C. tomentosa*, Lusby, Maryland, IX-16-2003, R.J. Gagné, deposited in USNM.

Etymology.—The name *hirtidolum*, a noun, combines the Latin words *hirtus* (hairy) and *dolum* (jar) and refers to the hairy, barrel-like gall.

Affinities.—See under *C. ciliolium*.

Collections of galls.—**ALABAMA:** Auburn (*ovata*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata*). **ARKANSAS:** Beulah (*tomentosa*). **CONNECTICUT:** Phoenixville (*ovata*). **GEORGIA:** Forsyth (*glabra*); Lizella (*tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Brighton (*tomentosa*); Clarksburg (*tomentosa*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*tomentosa*); St. Leonard (*tomentosa*); Snow Hill (*tomentosa*). **OKLAHOMA:** Sallisaw (*tomentosa*). **SOUTH CAROLINA:** Georgetown (*tomentosa*). **VIRGINIA:** Radford (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*tomentosa*); Walter Reed Army Medical Center (*tomentosa*).

Specimens of *C. hirtidolum* examined.—**ALABAMA:** Greenville, IX-20-2000 (larva). **ARKANSAS:** Beulah, IX-10-2004 (larva). **MARYLAND:** Beltsville, USDA Agricultural Research Center, VIII-25-2000 (larvae); Lusby, IX-16-2003 (larva); Silver Spring, IX-6-2003 (larvae).

Caryomyia hirtiglobus Gagné, new species

Description.—**Gall** (Figs. 53–54): Occasional, found on *Eucarya* hickories; single or clustered, on lower leaf surface between veins; 2.5–3.0 mm in height, depressed-spherical, occasionally weakly conical apically; covered with short, thick, brown hair obscuring gall surface; base of gall at center with short, conical pedicel at center of circular indentation, the corresponding leaf connection sur-

rounded by inconspicuous exfoliation of the leaf; wall firm, brittle, uniformly thin except slightly thicker at apex; larval chamber of same shape as gall, without conspicuous extension into basal pedicel, glabrous, green to purple, with longitudinal ridges. In outward appearance the gall of this species is generally similar to those of other spherical, hairy galls, especially those made by *C. purpurea* and *C. holotricha*, but when cut longitudinally, the gall's uniformly thin wall and its conical connection to the leaf will serve to distinguish it from otherwise superficially similar galls.

Adult: Head: Antenna with 12 flagellomeres, in male a short 13th flagellomere without circumfila present; each of regular 12 male flagellomeres (as in Fig. 239) binodal with definite internode and neck, circumfila with short loops, their bases widely separated; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 3.3–3.4 mm in male (n=2), 3.1–3.4 mm in female (n=4). **Male abdomen:** Third through eighth tergites each with posterior setae separated into 2 lateral groups, in single to double rows; eighth tergite not more weakly sclerotized than seventh. Genitalia: hypoproct parallel-sided, slightly concave posteromesally, margin setose, dorsum setulose only apically; apex of aedeagus convex. **Female abdomen:** Third through seventh tergites each with posterior setae in 2 lateral, mostly double rows; eighth tergite more weakly sclerotized than preceding tergite, with posterior setae only laterally and not as long as on preceding tergite. Ninth segment pliable except for dorsal sclerite that widens from base to apex, setae sparse laterally and ventrally, many longer than cerci. Cerci ovoid in lateral view, fused dorsally for about 2/3 length.

Pupa (Figs. 199–200): Antennal bases oblique in ventral view, converging and narrowing anteriorly, their rounded apices closely adjacent. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 2.0–2.6 mm (n=10). Body dorsoventrally flattened, elongate-ovoid, rounded at ends, segments convex. Head directed antero-ventrally. Spatula (Fig. 283) with 2 widely

separated anterior teeth, shaft widest anteriorly, narrowing abruptly to posterior half. Papillae mostly on short lobes, dorsals and pleurals with setae, also ventrals with setae on first through seventh abdominal segments. Lateral papillae usually 2, occasionally 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Body entirely covered with verrucae. Terminal segment as long as eighth. **Second instar:** Length 0.6–1.2 mm (n=9). Collar segment with patch of enlarged spicules on each side. Spatula present, with acutely triangular anterior tooth and longer, elliptical shaft. Dorsal and pleural papillae raised, about as long as wide, without setae. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. tomentosa*, Silver Spring, Maryland, IX-17-1993, R.J. Gagné, deposited in USNM.

Etymology.—The name *hirtiglobus* is a noun in apposition formed from the Latin *hirtus* (hairy) and *globus* (globe) with reference to the hairy, spherical gall.

Affinities.—This species forms a natural group with *C. caryae* and *C. shmoor* because of the general shape of the gall and the similarity of the larvae, particularly the 2 widely separated anterior teeth of the third instar spatula. A difference between this species and the other two is the lack of setae on the dorsal and pleural papillae of the second instar. See under *C. caryae* for further discussion.

Biological notes.—Galls of various sizes were first noticed on June 16 in central Maryland, with first instars in the smaller galls, second instars in the larger. The hair covering the gall is at first white, turning to brown by the time the gall is full size. Galls cut open on July 27 contained either second or third instars, both instars very active when touched. Their ventrally situated heads are closely appressed to the gall tissue so that the leading edge of the larva as viewed dorsally is the pronotum. Small specimens of third instars seen on August 19 were closely appressed to the curved gall interior. By mid-September fully-developed third instars are opaque white and stout with expanded segments, and are no longer so closely appressed to the larval chamber surface.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*tomentosa*); Greenville (*tomentosa*). **ARKANSAS:** Beulah (*tomentosa*); 2 mi S DeQueen (*tomentosa*); London (*tomentosa*); Palestine (*ovata*); Piney (*texana*). **CONNECTICUT:** Amston (*ovata*); Meriden (*glabra*); Plainfield (*ovata*);

Westchester (*ovata*). **FLORIDA:** Gainesville (*glabra*, *tomentosa*). **GEORGIA:** 8 km E Fort Valley (*pallida*); Lizella (*tomentosa*). **KENTUCKY:** Grayson Lake St. Pk, Carter Co. (*ovata*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra*, *tomentosa*); Gaithersburg (*tomentosa*); Piney Grove (*ovata*); Ridgely (*tomentosa*); Silver Spring (*tomentosa*). **MASSACHUSETTS:** Holyoke (*ovata*). **MISSISSIPPI:** Noxubee Natl Wildlife Ref., Oktibbeha Co. (*tomentosa*); 7 mi E Starkville (*pallida*, *tomentosa*). **MISSOURI:** Holly Ridge St. For., Stoddard Co. (*glabra*, *tomentosa*). **NEW YORK:** Hyde Park (*ovata*); Ithaca (*ovata*). **NORTH CAROLINA:** Gastonia (*tomentosa*). **OKLAHOMA:** Sallisaw (*tomentosa*). **TENNESSEE:** Mohawk (*tomentosa*). **VIRGINIA:** Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*).

Specimens of *C. hirtiglobus* examined.—**ARKANSAS:** Piney, X-10-2004 (larvae). **CONNECTICUT:** Amston, IX-19-1994 (larva). **GEORGIA:** 8 km E Fort Valley, X-11-1993, J. & R. Payne (larvae). **KENTUCKY:** Grayson Lake St. Pk, Carter Co., IX-22-1995 (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, X-5-1994 (larvae) & X-13-1999 (larvae; 3 ♀, pupae, emerged IV-2000); Gaithersburg, X-4-1994 (larvae); Ridgely, IX-23-1999 (larvae); Silver Spring, IX-20-1988, IX-17-1993, VII-27-1994, & VIII-1-2000 (larvae). **NEW YORK:** Hyde Park, IX-26-2004 (larva); Ithaca, IX-3-2003 (larva). **OKLAHOMA:** Sallisaw, IX-19-2004 (larvae). **VIRGINIA:** Ladysmith, IX-23-2000 (larvae; 2 ♂, 1 ♀, pupae, em. IV-2001). **WASHINGTON, DC:** National Arboretum, V-24-1994 (larvae).

Caryomyia holotricha (Osten Sacken)

Cecidomyia holotricha Osten Sacken 1862: 193; Felt 1909: 293 (*Caryomyia*).

Dirhiza caryae Felt 1907: 47; Felt 1921: 101 (*Caryomyia*, as synonym of *C. holotricha*); Gagné 2004: 100, as junior synonym of *C. caryae* (Osten Sacken).

Description.—*Gall* (Figs. 116–117): Common, on *Eucarya* hickories; usually clustered, on lower leaf surface between veins; 2.5–4.5 mm in height, from depressed-spherical with slight peak to onion shaped; with long, thick, brown hair obscuring gall surface; base with circular, deep, central excavation, leaf without exfoliation surrounding connection; larval chamber basal, ovoid, floccose, green to brown, occasionally with slight

violet hue, a tuft of brown hairs issuing from apex of larval chamber at end of fibrous bundle that terminates at gall apex; gall wall thick, woody. Galls are superficially similar to those of *C. aggregata* and *C. purpurea* because of their dense hair covering. Osten Sacken (1862) described two kinds of galls for this species. One kind is limited here as *C. holotricha* by the designation of the lectotype that shows a characteristic intrusion of hairs from the gall apex into the larval cavity. The other kind presumably belongs to *C. aggregata* but none of Osten Sacken's galls of that sort remain. Unlike galls of *C. holotricha* that are usually discrete and grow between veins, those of *C. aggregata* appear in closely packed rows along the midrib. It is not always possible to differentiate the more onion-shaped galls of *C. holotricha* from those of *C. purpurea* without opening them to see whether there is an apical intrusion of hairs that *C. purpurea* galls do not have. In addition, the inside surface of the *C. purpurea* galls is almost always purple instead of green to brown.

Adult: Head: Antenna with 12 flagellomeres; male flagellomeres (as in Fig. 239) binodal with definite internode and neck, circumfila loops short, their bases widely separated; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4 segmented. **Thorax:** Wing length 2.9–3.7 mm in male (n=5), 2.3–3.9 mm in female (n=5). **Male abdomen:** Third through eighth tergites each with posterior setae separated into two extensive lateral groups, almost joining mesally in posterior tergites, in single to double rows, sometimes partially triple rows on posterior tergites. Genitalia: hypoproct nearly parallel-sided, slightly concave posteromesally, margin setose except along concavity, setulose dorsally only on apical third; apex of aedeagus rounded; gonostylius not tapering, with wide tooth. **Female abdomen:** Third through eighth tergites usually with posterior setae in 2–3 lateral rows, sometimes almost joined mesally, especially on posterior segments, setae not as long or strong on eighth as on previous tergite. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci elongate-ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (Figs. 207–208): Antennal bases pyramidal, moderately separated, acutely pointed apico-

laterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 2.5–3.3 mm (n=10). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 327) with anterior tooth tapering from wide base to pointed apex, shaft widened at both ends, attenuated along midlength. Papillae without setae, their bases not raised. Lateral papillae 3 on each side of spatula, occasionally 2 on one side. Six dorsal papillae on first 7 abdominal segments. Abdominal segments completely covered with verrucae, those anteriorly and posteriorly on venter spiculose. Terminal segment shorter than eighth. **Second instar:** Length 2.5–3.3 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae somewhat raised, asetose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Caryomyia holotricha* (O.S.): *Lectotype*, here designated, gall from *Carya* sp., Washington, DC, Osten Sacken, deposited in USNM. *Paralectotypes*, 14 galls on one leaf, marked "typical form," same data as lectotype. Osten Sacken (1862) also evidently described for this species galls of *C. aggregata* as a second form, but none of these is present in the Osten Sacken collection. Osten Sacken wrote that if there were two species involved, he would retain the name for the first form, which is done here.

Caryomyia caryae (Felt): *Holotype* ♀, cecid. 58, taken on hickory, V-20-1906, Albany, New York, deposited in the New York State Museum in Albany. Felt (1921) listed his *C. caryae* as a junior synonym of both *C. caryae* (Osten Sacken) and *C. holotricha*. Felt's species definitely fits within the parameters of *C. holotricha*. The holotype is even labeled *C. holotricha* in Felt's handwriting, so the placement under *C. caryae* (O.S.) in Felt (1921) was evidently a lapsus.

Etymology.—Osten Sacken (1862) coined the name *holotricha* with reference to the hair that completely covers the gall. The name *caryae* means "of *Carya*."

Affinities.—Galls of this species and of *C. thompsoni* are the only ones with hairs intruding into the larval chamber from the apex of the gall.

The two species are alike in most particulars of adults, pupae, and larvae, but galls of *C. holotricha* lack the basal intrusion into the larval chamber present in *C. thompsoni* galls and are almost always conical rather than spheroidal.

Biological notes.—In central Maryland, soft, whitish-green galls were first noticed on June 9 and contained first instars. On June 15, galls were nearing full size and contained first instars. By June 17, some galls were hard and contained second instars, as well as young hymenopterous parasitoids. By June 22 and through July 16, all galls were at full size and hard. On August 3, galls contained large second instars. By August 31, more than 2/3 of the galls contained third instars. The full-grown larva is opaque white and practically fills the larval chamber. The exit tunnel is made to one side of the gall.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*glabra*, *pallida*, *tomentosa*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*pallida*). **ARKANSAS:** Beulah (*tomentosa*); Chester (*texana*); 2 mi S DeQueen (*tomentosa*); 3 mi S Harrison (*tomentosa*); London (*tomentosa*); Magazine Mt., Logan Co. (*texana*, *tomentosa*); Piney (*texana*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Litchfield (*ovata*); Hartland (*ovata*); Meriden (*glabra*, *ovata*); New Haven (*glabra*); Oakville (*ovata*); Phoenixville (*ovata*); Southbury (*glabra*, *tomentosa*); Southington (*ovata*); Thomaston (*ovata*). **FLORIDA:** Chattahoochee (*glabra*, *tomentosa*); Gainesville (*glabra*, *tomentosa*); Lake City (*glabra*, *tomentosa*). **GEORGIA:** Carnesville (*glabra*); 8 km E Fort Valley (*pallida*). **ILLINOIS:** Dexter (*laciniosa*); Marshall (*tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Grayson Lake St. Pk, Carter Co. (*glabra*, *ovata*); Morehead (*tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Pennyriile St. Pk, Christian Co. (*ovata*); Winchester (*laciniosa*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*texana*, *tomentosa*). **MARYLAND:** Beaver Dam (*tomentosa*); Beltsville, USDA Agricultural Research Center (*tomentosa*); Brighton (*tomentosa*); Clarksburg (*glabra*, *tomentosa*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*glabra*, *tomentosa*); Potomac (*tomentosa*); Ridgely (*glabra*, *tomentosa*); Silver Spring (*tomentosa*); Snow Hill (*tomentosa*); Wheaton (*glabra*). **MASSACHUSETTS:** Great Barrington (*ovata*); Leominster (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); Wrentham (*ovata*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 123, Rankin Co. (*pallida*, *tomentosa*); Noxubee Natl Wildlife Ref.,

Oktibbeha Co. (*tomentosa*). **MISSOURI:** Conway (*texana*); Holly Ridge State For., Stoddard Co. (*glabra*); St. Clair (*texana*, *tomentosa*). **NEW HAMPSHIRE:** Kingston (*ovata*). **NEW YORK:** Albany (*Carya* sp.); Hyde Park (*ovata*); Nassau (*Carya* sp.); New York (*Carya* sp.); Ravena (*glabra*); Shokan (*glabra*); West Point (*Carya* sp.). **NORTH CAROLINA:** Alamance (*tomentosa*); Fayetteville (*tomentosa*); Providence (*tomentosa*); Rowland (*tomentosa*); Wise (*tomentosa*). **OHIO:** Hocking St. For., Hocking Co. (*ovata*); St. Clairsville ((*tomentosa*); Yellow Springs (*glabra*). **OKLAHOMA:** Sallisaw (*tomentosa*). **PENNSYLVANIA:** Julian (*ovata*); Millsboro (*glabra*); Schellsburg (*glabra*, *tomentosa*). **SOUTH CAROLINA:** Dillon (*tomentosa*); Georgetown (*tomentosa*). **TENNESSEE:** Dandridge (*tomentosa*); Mohawk (*tomentosa*). **TEXAS:** Daingerfield St. Pk, Morris Co. (*tomentosa*); New Waverly (*tomentosa*). **VIRGINIA:** Warren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*); Dinwiddie (*tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*). **WASHINGTON, DC:** unspecified (*Carya* sp.); National Arboretum (*tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*ovata*, *tomentosa*); 6 mi NW Hedgesville (*tomentosa*).

Specimens of *C. holotricha* examined.—**CONNECTICUT:** Amston, IX-19-1994 (larvae); New Haven, IX-19-1994 (larvae); Phoenixville, IX-20-1994 (larvae). **GEORGIA:** 8 km E Fort Valley, X-11-1993, J. & R. Payne (larvae). **ILLINOIS:** Marshall, IX-7-2004 (larvae). **KENTUCKY:** Winchester, IX-22-1995 (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, X-5-1994 & VII-12-2000 (larvae), X-13-1999 (larvae; 3 ♂, 2 ♀, pupae, em. IV-2000), X-11-2005 (larvae; 5 ♂, 84 ♀, pupae, em. IV-2006); Brighton, X-8-1994 (2 ♂, 5 ♀, pupae, em. IV-1995); Gaithersburg, X-3-1999 (larvae); Lusby, IX-14-2005 (larvae; pupa excised from gall IV-7-2006); Ridgely, X-2-2000 (larvae; 9 ♂, 7 ♀, pupae, em. IV-2001); Silver Spring, X-3-1993 (larvae; 2 ♂, 3 ♀, pupae, em. IV-1994); Wheaton, X-13-1999 (larvae). **MASSACHUSETTS:** Beverly, 190?, C.H. Clarke (♂, 2 ♀, larva); Boston, 190?, C.H. Clarke (♂, ♀, larva); Leominster, IX-21-1994 (larva). **NEW HAMPSHIRE:** Kingston, IX-21-1994 (larvae; 3 ♂, 4 ♀, em. IV-1995). **NEW YORK:** Albany, found on hickory, V-20-1906 (♀, holotype of *C. caryae* (Felt)); E. Schodack, 190?, E.P. Felt (2 ♂, 2 ♀); New York City, X-15-1908, E.P. Felt (larva; ♂, ♀, pupae, em. IV-22-1909). **NORTH CAROLINA:** Asheville, E.P. Felt, IX-16-2006 (larva). **OHIO:**

Hocking St. For., Hocking Co., IX-19-1995 (larvae); Yellow Springs, IX-7-2004 (larvae). **TENNESSEE:** Mohawk, IX-12-2004 (larvae). **TEXAS:** New Waverly, X-2001 (3 ♂, 4 ♀, pupae, em. IV-2002). **WASHINGTON, DC:** unspecified (type series of *C. holotricha*); National Arboretum, IX-27-2005 (larvae; 3 ♂, 12 ♀, pupae, em. IV-2006); Walter Reed Army Medical Center, X-1999 (larvae; 2 ♀, pupae, em. IV-2000) and X-2004 (4 ♀, em. IV-1-2005). **WEST VIRGINIA:** 6 mi NW Hedgesville, IX-19-1999 (larvae).

Caryomyia inanis Felt

Caryomyia inanis Felt 1909: 292.

Description.—*Gall* (Figs. 8, 98–99): Occasional, on *Eucarya* hickories, not found east of the Appalachian Mts (Map 2); found singly or in groups on lower leaf surface, between veins; length 2.5–4.0 mm, spheroidal at base with short to long, foliate, papery, lateral extension forming partial false chamber, the distal opening broadly agape to nearly closed; apex of closed part of gall slightly convex with central nipple often bearing thin, horizontal, flat disk (the leaf surface beneath which gall issued) equal to more than 1/3 gall diameter; green to brown with sparse, long, white or brown hairs not obscuring gall surface; base with prominent conical projection in center of circular indentation, leaf with thin exfoliation surrounding gall base; larval chamber ovoid, wall firm, brittle, uniformly thin, smooth with longitudinal ridges. This gall has a similar structure to that of *C. asteris*, although that is not at first apparent. The foliate extension of the gall of *C. inanis* is vertical and tubular, while that of *C. asteris* is horizontally disposed.

Adult: **Head:** Antenna with 12 flagellomeres; each of male flagellomeres (as in Fig. 237) scarcely binodal, distance between nodes marked mainly by disruption of setulae and slight compression between basal and middle circumfila, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4 segmented. **Thorax:** Wing length 2.1–2.2 mm in male (n=2); 2.5–2.8 mm in female n=(5). **Male abdomen:** Third through seventh tergites each with posterior setae in 2–3 rows laterally, narrowing to 1–2 mesally; eighth tergite

without posterior setae. Genitalia: hypoproct broadest before posterior convex margin, margin setose, dorsal surface setulose only on apical fourth; aedeagus evenly cylindrical, wide, barely notched apically. **Female abdomen:** Third through seventh tergites as for male; eighth tergite not so strongly sclerotized as preceding tergite, with 0–2 posterior weak posterior setae each side. Ninth segment (Fig. 266) rigid, pigmented, with sparse, long setae. Cerci pointed, almost fully fused dorsally.

Pupa (as for Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.5–1.8 mm (n=8). Body elongate-fusiform, anterior end broadly rounded, posterior end tapering to weak point. Head directed anteroventrally. Spatula (Fig. 301) with parallel-sided, apically notched tooth and narrow shaft. Papillae without setae, their bases raised, especially those of dorsal, pleural, and terminal papillae. Lateral papillae 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments completely covered with verrucae. Terminal segment as long as eighth and nearly pointed. **Second instar:** Length 1.0–1.3 mm (n=4). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, posteriorly widened shaft. Bases of dorsal and pleural papillae raised, papillae asebose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Lectotype* here designated, ♀, reared from *Carya* sp., IV-29-1909, Nassau, New York, Ca1950, deposited in New York State Museum, Albany. *Paralectotype* ♀, same data as lectotype.

Etymology.—The name *inanis* is a Latin adjective for “empty,” probably coined with reference to the false chamber above the larval chamber.

Affinities.—This species and *C. asteris* are similar for their fusiform larvae with raised, but asebose papillae. An important difference between the two is the presence in only *C. asteris* of setae on the dorsal and pleural papillae of the second instar. Galls of the two also are generally similar, the main difference being that the exfoliate part of the gall beyond the larval chamber is vertical and

continuous in *C. inanis* but horizontal and starlike in *C. asteris*. The present species is striking for its completely sclerotized ovipositor with its nearly completely joined cerci. The adult stage of *C. asteris* has not yet been reared.

Biological notes.—In mid-June in eastern West Virginia, galls were almost full grown and light green with the exfoliate part still easily pliable and contained second instars. In early July, galls were still green but with third instars that were very active when the galls were opened. In August the galls had turned brown.

Collections of galls.—CONNECTICUT: Amston (*ovata*); Danbury (*ovata*); Harwinton (*ovata*); Hopeville (*ovata*); Litchfield (*ovata*); Meriden (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Southington (*ovata*); Thomaston (*ovata*). KENTUCKY: My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Winchester (*laciniosa*). MAINE: Eliot (*tomentosa*); North Berwick (*ovata*). MASSACHUSETTS: Great Barrington (*ovata*); Holyoke (*ovata*); Magnolia (*Carya* sp.); Merrimac (*ovata*); Petersham (*ovata*). NEW HAMPSHIRE: Exeter (*ovata*); Greenland (*ovata*). NEW JERSEY: Worthington (*ovata*). NEW YORK: Herkimer (*ovata*); Ithaca (*ovata*); Nassau (*Carya* sp.); New York (*Carya* sp.); Ravena (*ovata*); Shokan (*tomentosa*). OHIO: Athens Co. (*tomentosa*, Wells 1916: Fig. 8); Summerford (*tomentosa*). PENNSYLVANIA: Kirby (*ovata*); Pavia (*ovata*). TENNESSEE: Greene Co., I 81, Mile 38.5 (*tomentosa*). WEST VIRGINIA: 6 mi NW Hedgesville (*ovata, tomentosa*).

Specimens of *C. inanis* examined.—CONNECTICUT: Amston, IX-19-1994 & IX-17-1999 (larvae); Litchfield, IX-7-2005 (7 ♀, pupal exuviae, em. IV-24 to 25-2006); Phoenixville, IX-20-1994 (larvae). KENTUCKY: Winchester, IX-22-1995 (larva). MAINE: North Berwick, IX-21-1994 (larva). NEW HAMPSHIRE: Exeter, IX-21-1994 (larvae; ♂, 2 ♀, pupae, em. IV-1995). NEW JERSEY: Worthington, IX-8-2000 (larva). NEW YORK: Nassau, E.P. Felt (2 ♀, type series, em. IV-29-1909). OHIO: Summerford, IX-7-2004 (larvae). WEST VIRGINIA: 6 mi. NW Hedgesville, X-2000 (larvae; ♂, 2 ♀, em. IV-2001), X-1-1995, IX-19 & X-17-1999, & VII-4-2000 (larvae).

Caryomyia inclinata Gagné, new species

Description.—*Gall* (Figs. 145-146): Occasional, locally common but not east of Appalachian Mts, on *Eucarya* hickories; on lower leaf surface, on veins; length from center of base to tip 3.3-7.0 mm, leaning, irregularly conical, base prolonged

and irregularly lobed opposite direction of incline, the apex with short or long taper, digitate when long; sparsely covered with short, white hair not obscuring green, red, to brown surface; base at center flat or tapered to short-conical pedicel; larval chamber basal, green, with longitudinal ridges, remaining gall tissue woody. Galls are most like those of *C. ansericollum*, but in that species the base is not conspicuously flattened and outspread to one side opposite the direction of the cone.

Adult: **Head:** Antenna with 12 flagellomeres; male flagellomeres scarcely binodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose (as in Fig. 242). Palpus 4 segmented. **Thorax:** Wing length 1.9-2.1 mm in male (n=3); 2.5-2.7 mm in female (n=3). **Male abdomen:** Third through seventh tergites each with posterior setae continuous across width, in mostly single row; eighth tergite more weakly sclerotized, with 0-2 posterior setae laterally. Genitalia: hypoproct broadest just anterior to apex, posterior margin sinuous, setose except along mesal concavity, setulose dorsally on distal fourth; apex and venter of aedeagus furrowed. **Female abdomen:** Third through seventh tergites each with posterior setae continuous across width, in mostly double row laterally, tapering to single row mesad; eighth tergite with a group of weak setae laterally. Ninth segment (Fig. 262) pliable except for fairly wide dorsal sclerite, setae long but sparse. Cerci elongate-ovoid, pointed apically, pigmented, fused dorsally on basal third.

Pupa (as in Figs. 213-214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.4-2.3 mm (n=10). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 320) with acutely pointed tooth and elongate, wide shaft. Papillae without setae, not conspicuously raised. Lateral papillae 2-3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with

verrucae present at midlength on dorsum and with spicules present anterior to sternal papillae and on posterior third of venter. Terminal segment shorter than eighth. **Second instar:** Length 0.7–0.9 mm (n=6). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae setose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. tomentosa*, 6 mi NW Hedgesville, West Virginia, IX-19-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *inclinata* is a Latin adjective with reference to the gall's leaning habit.

Affinities.—Galls of a group of five species are conical, woody, and have more or less digitate apices, but are still distinct in shape and vestiture. Both sexes of the present species and the female of *C. ansericollum* are known; the ovipositor of both species is similarly long and sparsely setose. The other three species are *C. guttata*, *C. cucurbitata*, and *C. echinata*, known only from their larvae. Larvae of all five species have only four papillae on the first through seventh abdominal segments, but the spatula of the last two named species are notched anteriorly and the other three have a triangular tooth.

Biological notes.—Between June and beginning August in eastern West Virginia, young and full-grown galls can be found, containing first and second instars, respectively. By the first week of August galls contain either second or third instars. Pupae emerge through the side of the gall near the base.

Collections of galls.—**ARKANSAS:** Palestine (*ovata*); Winslow (*ovata*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Hartland (*ovata*); Harwinton (*ovata*); Hopewill (*ovata*); Meriden (*tomentosa*); Phoenixville (*ovata*); Plainfield (*ovata*); Thomaston (*ovata*). **ILLINOIS:** Dexter (*laciniosa*); Marshall (*tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Grayson Lake St. Pk, Carter Co. (*ovata*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*). Winchester (*laciniosa*). **MAINE:** Eliot (*tomentosa*); North Berwick (*ovata*). **MASSACHUSETTS:** Great Barrington (*ovata*); Holyoke (*ovata*); Leominster (*ovata*); Petersham (*ovata*). **NEW HAMPSHIRE:** Barrington (*ovata*); Greenland (*ovata*). **NEW JERSEY:** Columbia (*ovata, tomentosa*). **NEW YORK:** Herkimer (*ovata*); Ithaca (*ovata*); Saratoga Springs (*ovata*). **NORTH CAROLINA:** Kannapolis (*tomentosa*).

OHIO: St. Clairsville (*tomentosa*); Summerford (*tomentosa*). **ONTARIO:** Dundas (*ovata*). **TAMAULIPAS:** SW of Ciudad Victoria (*ovata*, var. *mexicana*; photos only). **WEST VIRGINIA:** Cacapon (*ovata*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. inclinata* examined.—**CONNECTICUT:** Amston, IX-19-1994 & IX-17-1999 (larvae); Phoenixville, IX-20-1994 (larva). **KENTUCKY:** Grayson Lake St. Pk, Carter Co., IX-22-1995 (larva). **MASSACHUSETTS:** Leominster, IX-21-1994 (larva). **NEW YORK:** Herkimer, IX-4-2003 (larvae); Saratoga Springs, IX-25-1994 (larva). **OHIO:** Summerford, IX-7♂ 2004 (larva). **ONTARIO:** Dundas, VIII-17-1994 (larvae). **WEST VIRGINIA:** 6 mi NW Hedgesville, X-1999 (larvae; ♂, ♀, pupae, em. IV-2000), X-2000 (larvae; ♂, 2 ♀, em. IV-12-2001), X-3-2003 (5 ♀, em. IV-12-2004), IX-19-1999 & VII-23-2000 (larvae), IX-30-2005 (♀, em. IV-12-2006).

Caryomyia inflata Gagné, new species

Description.—*Gall* (Figs. 5a, 102–103): Occasional, on *Eucarya* hickories, but not found on Atlantic side of Appalachians NE of central Georgia (Map 2); usually clustered, on lower leaf surface between veins; 2.2–4.0 mm in height, obconic, the apical cap convex early, becoming flat or slightly depressed at maturity, with central umbo; green, occasionally red, turning gray or brown with age, smooth, hairless, not sticky; base tapered to conical pedicel, leaf with slight exfoliation around connection forming short, tubular socket and on reverse side showing discolored convexity; inside are a basal ovoid larval chamber and apical, equal-sized to larger and much broader, closed, false chamber, the basal larval chamber separated from apical chamber by thin wall with central umbo, walls thin, elastic at first, becoming brittle, both chambers longitudinally striate. This gall is most similar to that of *C. tumida*. The two are similarly shaped except that the gall of *C. tumida* is completely covered with short, decumbent hair.

Adult: **Head:** Antenna with 12 flagellomeres; male flagellomeres (as in Fig. 237) scarcely binodal, distance between nodes marked mainly by disruption of setulae and slight compression between basal and middle circumfila, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. **Labella** (Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. **Palpus** 4-segmented. **Thorax:**

Wing length 2.0–2.1 mm in male (n=2); 2.2–2.5 mm in female (n=3). **Male abdomen:** Third through seventh tergites each with posterior setae in mesally interrupted, mostly single row; eighth tergite with 2–3 posterior setae laterally. Genitalia (as in Figs. 247–248): hypoproct broadest before posterior concave margin, margin setose except in concavity, dorsum setulose only on apical fourth; aedeagus deeply furrowed apically. **Female abdomen:** Third through seventh tergites as for male; eighth tergite with 0–3 posterior setae laterally. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci elongate-ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (Figs. 209–210): Antennal bases separate, acutely pointed apicolaterally. Face with antero-lateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 2.4–2.8 mm (n=6). Body cylindrical, anterior and posterior ends rounded. Head directed anteroventrally. Spatula (Fig. 313) with nearly parallel-sided anterior tooth only about as long as wide, obtusely notched at apex, the shaft parallel-sided, approximately as wide as tooth. Two lateral papillae each side of spatula. Papillae without setae, bases not raised. Six dorsal papillae on first 7 abdominal segments. Abdominal segments with sparse verrucae dorsally at midlength surrounding dorsal papillae, and with horizontal rows of sharp, pointed spicules ventrally, anterior to sternal papillae, but not on posterior margin of segments. Terminal segment shorter than eighth. **Second instar:** Length 0.9–1.2 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with short right-triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, short-setose. Usually 6 dorsal papillae on first 6 abdominal segments, but outer pair not always expressed; with only 4 on seventh segment.

Type material.—*Holotype*: Third instar (right-most specimen of 4 larvae on slide), from gall on *C. tomentosa*, 6 mi NW Hedgesville, West Virginia, IX-26-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *inflata* is a Latin adjective referring to the inflated false chamber of this gall.

Affinities.—This species and *C. tumida* come from similarly shaped, two-chambered galls, but that of *C. inflata* is smooth, the other thickly covered with short, decumbent hairs. Beyond that, the galls have certain similarities to that of *C. asteris*. Although the latter gall is not two-chambered, second instars of all three species have setose dorsal and pleural papillae. The rays of the *C. asteris* gall may indicate some midpoint development of a strictly two-chambered gall.

Biological note.—Pupae emerge from a hole at the base of the gall next to the leaf connection.

Collections of galls.—**ALABAMA:** Oak Mt. St. Pk, Shelby Co. (*pallida*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Litchfield (*ovata*); Hartland (*ovata*); Harwinton (*ovata*); Meriden (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Westchester (*ovata*). **GEORGIA:** Forsyth (*glabra*, *ovata*); Lizella (*ovata*). **ILLINOIS:** Highland (*laciniosa*). **INDIANA:** New Castle (*glabra*). **KENTUCKY:** Grayson Lake St. Pk, Carter Co. (*glabra*, *tomentosa*). **MAINE:** Eliot (*tomentosa*); North Berwick (*ovata*); Seabrook (*ovata*). **MASSACHUSETTS:** Boston (*ovata*); Holyoke (*ovata*); Leominster (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); vic. Worcester (*Carya* sp., Thompson 1915: 93, Fig. 228). **MISSISSIPPI:** Noxubee Natl Wildlife Ref., Oktibbeha Co. (*tomentosa*). **NEW JERSEY:** Columbia (*ovata*). **NEW YORK:** Ithaca (*ovata*). **OHIO:** Hocking St. For., Hocking Co. (*ovata*); unspecified (*Carya* sp., Wells 1916: Fig. 5a); Huron Co. (*C. glabra*, Sears 1914: Fig. 18). **TENNESSEE:** Greene Co., I 81, Mile 38.5 (*ovata*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); 6 mi NW Hedgesville (*ovata*, *tomentosa*).

Specimens of *C. inflata* examined.—**CONNECTICUT:** Harwinton, IX-6-2005 (pupae, 6 ♀, em. IV-25 to V-7-2006). **GEORGIA:** Lizella, X-12-1993, J. & R. Payne (larva). **KENTUCKY:** Grayson Lake St. Pk, Carter Co., IX-22-1995 (larva). **MAINE:** North Berwick, IX-21-1994 (larvae; 2 ♂, 3 ♀, pupae, em. IV-1995). **MASSACHUSETTS:** Leominster, IX-21-1994 (larvae). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co., VII-18-1988 (larvae); 6 mi NW Hedgesville, IX-4 & 26-1999 (larvae; 5 ♀, pupae, em. IV-2000), X-1-1995, VII-8-2000 & VIII-27-2000 (larvae).

Caryomyia lenta Gagné, new species

Description.—**Gall** (Figs. 5, 106–107): Occasional, on *Eucarya hickories*, not found east of the Appalachian Mts (Map 2); on lower or upper (one example) leaf surface between veins; height 3.3– 5.0 mm, depressed-spheroidal, sometimes

conical, with small nipple or tiny opening at center apex; rough textured, sticky, hairless, light green turning brown; base with central conical pedicel, leaf with raised, wide, mucilaginous, brown ring surrounding connection with gall and on reverse side showing discolored, hardened convexity; wall thin, rubbery, larval chamber surrounded laterally and apically by much larger, false chamber, the chambers separated by hemispherical, thin, sticky wall, both chambers longitudinally striate. The one instance of a gall on the upper leaf surface (Amston, CT) occurred on a leaf that also had a gall on the lower surface. This gall is superficially similar to that of *C. inflata* except that the present gall is extremely sticky to the touch and its false chamber nearly completely surrounds the top and sides rather than sits atop the larval chamber.

Adult and pupa: Unknown.

Larva: **Third instar:** Length 2.0–2.6 mm (n=10). Body cylindrical, anterior and posterior ends rounded. Head directed anteroventrally. Spatula (Fig. 318) tooth with single, acute point, the shaft wider, elongate. Lateral papillae 2 on each side of spatula. Usually 6 papillae on first 7 abdominal segments but outer pair on 6th and 7th segments not expressed on some specimens. Papillae without setae, bases not conspicuously raised. Abdominal segments dorsally with verrucae only at midlength close to dorsal papillae and ventrally with horizontal rows of sharp spicules anterior to sternal papillae and at posterior fourth of segments. Terminal segment shorter than eighth. **Second instar:** Length 1.1–1.2 mm (n=4). Collar segment with patch of enlarged spicules on each side. Spatula with equilateral anterior tooth and longer, wider, rectangular shaft. Bases of dorsal and pleural papillae slightly raised, papillae asetose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype:* Third instar, from gall on *C. tomentosa*, 6 mi NW Hedgesville, West Virginia, X-17-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *lenta* is a Latin adjective meaning sticky or pliant, both qualities of the gall.

Affinities.—The two-chambered gall has certain aspects in common with those of *C. inflata* and *C. tumida*, all of them with a false chamber, but the surface of the gall of the present species is sticky, the false chamber is much larger to cover the sides as well as the top of the larval chamber, and its base is surrounded by a large leaf socket.

The third instar spatula of the present species is acutely toothed but those of the other two species are notched.

Collections of galls.—**CONNECTICUT:** Amston (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*). **ILLINOIS:** Marshall (*tomentosa*); Rock Island (*tomentosa*, B.D. Walsh). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Winchester (*laciniosa*). **MAINE:** North Berwick (*ovata*). **MASSACHUSETTS:** Magnolia (*Carya* sp.); Petersham (*ovata*). **PENNSYLVANIA:** Pavia (*ovata*). **NEW YORK:** Herkimer (*ovata*). **OHIO:** Athens & Hocking Counties (*tomentosa*, Wells 1916: Fig. 5); Summerford (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); 6 mi NW Hedgesville (*ovata*, *tomentosa*).

*Specimens of *C. lenta* examined.*—**CONNECTICUT:** Amston, IX-19-1994 (larvae). **ILLINOIS:** Marshall, IX-7-2004 (larva); Rock Island, B.D. Walsh (larva). **MAINE:** North Berwick, IX-21-1994 (larvae). **OHIO:** Summerford, IX-7-2004 (larvae). **WEST VIRGINIA:** 6 mi. NW Hedgesville, IX-3 to 19-1999, VIII-16-2000 & IX-30-2005 (larvae).

Caryomyia levicrustum Gagné, new species

Description.—*Gall* (Figs. 86-87): Common, on *Eucarya* hickories; on lower leaf surface between or on veins, usually clustered; height 2.2–3.0 mm, conical at base, cylindrical or flaring beyond, about as wide as long, the apex flat or shallowly to deeply convex, the walls surrounding any apical concavity variously flared outwards, evenly cylindrical, or almost closed to form partial false chamber, the center of apex with short umbo; surface glabrous, not sticky, green to tan; base conical, area of contact with leaf surrounded by thin leaf exfoliation; wall firm, brittle, thin basally, usually slightly thicker apically, larval chamber shiny, smooth, with longitudinal ridges. A variety of gall shapes is included under this heading, but the variation involves only the structure above the larval chamber and the galls are otherwise similar in color and lack of sticky exudate.

Adult (female only): Head: Antenna with 12 flagellomeres; flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, and setulose. Palpus 4 segmented. *Thorax:* Wing length 1.8–2.1 mm (n=3). *Female abdomen:* Third through seventh tergites each with single row posterior setae, sparse mesally; eighth tergite with 0–2 posterior setae

laterally. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa: Unknown.

Larva: **Third instar:** Length 1.2–1.6 mm (n=10). Body elongate-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 290) with anterior tooth an equilateral triangle, the shaft wide anteriorly, narrowed and linear beyond. Papillae without setae, bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with no verrucae on dorsum or sparse verrucae only near bases of lateral pairs of dorsal papillae and with spicules on venter anterior to sternal papillae. Terminal segment shorter than eighth. **Second instar:** Not seen.

Type material.—**Holotype:** Third instar, from gall on *C. tomentosa*, Entomology Road, BARC, Beltsville, Maryland, IX-26-1993, R.J. Gagné, deposited in USNM.

Etymology.—The name *levicrustum*, a noun, combines the Latin *levis* (smooth) and *crustum* (tart) and refers to the glabrous surface of the tart-like gall.

Affinities.—Galls of this species appear most like those of *C. flaticrustum* but instead of being soft and resinous, are hard and glabrous. For further remarks, see under *C. flaticrustum*.

Biological notes.—In central Maryland galls were noticed as early as mid-June. Galls with second and third instars could be found from then through August. In late March and early April, pupae break out from the side of the galls near the base.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*ovata, tomentosa*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata, pallida*). **ARKANSAS:** 3 mi S Harrison (*tomentosa*); London (*tomentosa*); Magazine Mt., Logan Co. (*ovata, texana, tomentosa*); 2 mi S DeQueen (*texana, tomentosa*); Rt.1 at Red River, Little River Co. (*tomentosa*). **CONNECTICUT:** Amston (*ovata*); Meriden (*glabra, ovata*); New Haven (*glabra*); Phoenixville (*ovata*); Plainfield (*ovata*); Southbury (*glabra, tomentosa*). **FLORIDA:** Ponce de Leon (*glabra*). **GEORGIA:** Carnesville (*glabra*); 8 km E Fort Valley (*pallida*); Forsyth (*glabra, ovata*); Lizella (*ovata, tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson Lake St.

Pk, Carter Co. (*tomentosa*); Morehead (*tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Pennyrite St. Pk, Christian Co. (*glabra, ovata*); Winchester (*laciniosa*). **MAINE:** North Berwick (*ovata*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Brighton (*tomentosa*); Clarksburg (*tomentosa*); Ellington City (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*glabra, tomentosa*); Potomac (*tomentosa*); Ridgely (*tomentosa*); St. Leonard (*tomentosa*); Silver Spring (*glabra, tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra, tomentosa*). **MASSACHUSETTS:** Great Barrington (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); Wrentham (*ovata*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 123, Rankin Co. (*tomentosa*); Natchez Trace Pkwy, Mile 193, Choctaw Co. (*glabra, pallida, tomentosa*); Noxubee Natl Wildlife Ref., Oktibbeha Co. (*ovata, tomentosa*); nr. Sessums, Oktibbeha Co. (*ovata*); 7 mi E Starkville (*pallida*). **MISSOURI:** Conway (*ovata*); Crowley Ridge Roadside Pk, Stoddard Co. (*glabra, tomentosa*); Holly Ridge State For., Stoddard Co. (*glabra, tomentosa*). **NEW HAMPSHIRE:** Barrington (*ovata*); Dover (*ovata*); Kingston (*ovata*). **NEW JERSEY:** Columbia (*ovata*); Nyack (*tomentosa*); Columbia (*tomentosa*). **NEW YORK:** Saratoga Springs (*ovata*). **NORTH CAROLINA:** Alamance (*tomentosa*); Alberta (*glabra*); Fayetteville (*tomentosa*); Gastonia (*tomentosa*); Providence (*glabra, tomentosa*); Rowland (*tomentosa*); Wise (*tomentosa*). **OHIO:** Hocking St. For., Hocking Co. (*tomentosa*). **OKLAHOMA:** Sallisaw (*tomentosa*). **SOUTH CAROLINA:** Richland Co. **TENNESSEE:** Crossville (*pallida, tomentosa*); Gatlinburg (*glabra, tomentosa*); Greene Co., I 81, Mile 38.5 (*ovata, tomentosa*). **TEXAS:** Daingerfield St. Pk, Morris Co. (*tomentosa*). **VIRGINIA:** Warren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*); Carson (*tomentosa*); Dinwiddie (*glabra, tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); I 81, Mile 13.9, Washington Co. (*ovata*). **WASHINGTON, DC:** National Arboretum (*glabra, tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); Cooper's Rock St. Pk, Preston Co. (*glabra*). 6 mi NW Hedgesville (*ovata, tomentosa*).

Specimens of *C. levicrustum* examined.—**ALABAMA:** Auburn, IX-19-2000 (larvae); Greenville, IX-20-2000 (larvae; 2 ♀, em. IV-2001). **CONNECTICUT:** Phoenixville, IX-20-1994 (larvae); Plainfield, VIII-27-1988 (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, IX-26-1993

(larvae) & X-28-1994 (larvae; ♀, em. IV-1995); Lusby, IX-16-2003 (larvae). OKLAHOMA: Sallisaw, IX-9-2004 (larvae). VIRGINIA: Huntley Meadows Pk, Fairfax Co., VIII-30-2000 (larvae).

Caryomyia leviglobus Gagné, new species

Description.—**Gall** (Figs. 19, 62–63): Common, on *Eucarya* hickories; single or dispersed on lower leaf surface between veins; 2.8–3.5 mm in height, spherical with a conspicuous apical terminus made up of a nipple atop an abruptly raised areola; hairless, not sticky, glabrous, light green, becoming yellow, green, or brown; base with small conical pedicel, leaf without exfoliation; wall firm, brittle, uniformly thin, larval chamber glabrous with longitudinal ridges. Wells (1916) wrote that the gall resembled a small bomb. This gall differs from that of *C. spiniglobus* in that it lacks hair. Both galls are distinctive for their conspicuous apical knob.

Adult: Head: Antenna with 12 flagellomeres; each of the 12 male flagellomeres (as for Fig. 237) scarcely binodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella (as in Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 2.0–2.1 mm in male (n=3); 2.2–2.5 mm in female (n=5). **Male abdomen:** Third through seventh tergites each with mostly single row of posterior setae nearly continuous across width, interrupted for a short space mesally; eighth tergite without posterior setae. Genitalia: hypoproct broadest before convex posterior margin, margin setose; aedeagus evenly cylindrical, notched apically. **Female abdomen:** Third through seventh tergites each with single row of posterior setae nearly continuous across width except interrupted mesally; eighth tergite as sclerotized as preceding tergite, with a few posterior setae laterally, the setae as long as on seventh tergite. Ninth segment pliable except for slender dorsal sclerite that widens apically to invest part of cerci, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally, mostly shorter than lateral setae. Cerci elongate-ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (Figs. 203–204): Antennal bases oblique in ventral view, converging and narrowing anteri-

orly, their narrowly rounded apices closely adjacent. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 2.5–3.5 mm (n=10). Body spindleform, segments convex, head end tapered, posterior end rounded. Head ventral. Spatula (Fig. 281) with large, simple anterior tooth nearly as long as broad shaft. All papillae except terminals setose, papillary bases not conspicuously raised. Lateral papillae numbering 2 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments completely covered with raised, pointed verrucae. Terminal segment as long as eighth. **Second instar:** Length 0.9–1.5 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with apically pointed tooth and rectangular or triangular shaft. Bases of dorsal and pleural papillae raised and all short-setose including on prothorax. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Larva, from gall on *C. tomentosa*, vic. Ridgely, Maryland, IX-23-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *leviglobus* is a noun in apposition formed from the Latin *levis* (smooth) and *globus* (globe) with reference to the hairless, spherical gall.

Affinities.—This species does not differ from *C. spiniglobus* except in the exterior of the gall that is smooth in *C. leviglobus* and stiff-haired in *C. spiniglobus*. I found galls of both species at the same site, but not in proximity on the same leaflet, so consider them separate species. While *C. leviglobus* is more common than *C. spiniglobus*, both are generally widespread. Together these species are unique in Cecidomyiini for their setose ventral larval papillae of the eighth abdominal segment. This character state is a defining one for the tribe Lasiopteridi; as far as I know these two species are the only Cecidomyiidi with setose ventral papillae, which is evidently a reversal here. The larval sternal papillae are also setose, unlike all Cecidomyiinae with the exception of the subtribe Asphondyliina. As with other species (viz. the *C. caryae* and *C. cilidolium* groups) that live unconstrained in a rather large, spherical larval chamber, the integument is completely covered with spiny verrucae that evidently allow

these species purchase in crawling across the curved surface of the larval chamber.

Biological notes.—Tiny, soft, light green galls with first instars were first noted in central Maryland on June 10. After mid-June galls in various stages of hardening yielded all instars including thirds. Adults emerged from a slight bulge in the side of the gall that was evidently weakened by the larva the previous autumn.

Collections of galls.—**ALABAMA:** Auburn (*pallida, tomentosa*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata, pallida, tomentosa*). **ARKANSAS:** Beulah (*tomentosa*); 2 mi S DeQueen (*texana, tomentosa*); Magazine Mt., Logan Co. (*ovata*); Osage (*texana*); Piney (*texana*). **CONNECTICUT:** Amston (*ovata*); Meriden (*glabra, ovata*); Natchaug St. For. (*ovata*); New Haven (*glabra*); Oakville (*ovata*); Westchester (*ovata*). **FLORIDA:** Gainesville (*glabra*). **GEORGIA:** Carnesville (*glabra*); Forsyth (*glabra, ovata*); 8 km E Fort Valley (*pallida*); Lake Park (*glabra*); Lizella (*ovata, tomentosa*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson L. St. Pk, Carter Co. (*glabra*); Pennyrite St. Pk, Christian Co. (*ovata*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*texana, tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Calverton (*tomentosa*); Clarksburg (*glabra, ovata, tomentosa*); College Park (*glabra*); Gaithersburg (*tomentosa*); Kemp Mill (*ovata, tomentosa*); Lusby (*glabra, tomentosa*); Potomac (*tomentosa*); Ridgely (*tomentosa*); St. Leonard (*tomentosa*); Silver Spring (*glabra*); Spencerville (*tomentosa*); Wheaton (*glabra*). **MASSACHUSETTS:** Wrentham (*ovata*). **MISSISSIPPI:** Noxubee Natl Wildlife Refuge (*ovata*); Okfobeha Co., nr. Sessums (*ovata*). **MISSOURI:** Conway (*ovata, texana*); Holly Ridge St. For., Stoddard Co. (*tomentosa*); Rolla (*texana*); St. Clair (*tomentosa*); Wildwood (*tomentosa*). **NEW HAMPSHIRE:** Kingston (*ovata*). **NEW YORK:** Shokan (*glabra*). **NORTH CAROLINA:** Alamance (*tomentosa*); Alberta (*glabra*); Gastonia (*tomentosa*); Kannapolis (*tomentosa*); Rowland (*tomentosa*); Wise (*tomentosa*). **OHIO:** Hocking St. For., Hocking Co. (*ovata*); Hocking Co. (*ovata*, Wells 1916: Fig. 19); Yellow Springs (*glabra*). **OKLAHOMA:** Sallisaw (*tomentosa*). **TENNESSEE:** Crossville (*pallida*); Dandridge (*tomentosa*); Dickson (*tomentosa*); Greene Co., I 81, Mile 38.5 (*tomentosa*); Jackson (*tomentosa*); Lebanon (*glabra*); Mohawk (*tomentosa*). **TEXAS:** Daingerfield St Pk, Morris Co. (*tomentosa*); New Waverly (*tomentosa*). **VIRGINIA:** Carson (*tomentosa*); Dinwiddie (*glabra*); Huntley Meadows, Fairfax Co. (*tomentosa*); War-

ren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*). **WASHINGTON, DC:** National Arboretum (*glabra, tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** 6 mi NW Hedgesville (*ovata*).

Specimens of *C. leviglobus* examined.—**CONNECTICUT:** Amston, IX-19-1994 (larva); New Haven, IX-19-1994 (larva). **GEORGIA:** 8 km E Fort Valley, IX-11-1993, J. & R. Payne (larvae). **KENTUCKY:** Brownsville, IX-29-1995 (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, IX-28-1999 & VII-22-2000 (larvae); Gaithersburg, VII-20-2000 (larvae); Lusby, IX-2003 (2 ♂, 4 ♀, em. IV-11-2004); vic. Ridgely, IX-23-1999 (larva); Wheaton, IX-19-1993 (larvae). **MASSACHUSETTS:** Wrentham, IX-20-1994 (larvae; 2 ♀, em IV-1995). **NEW HAMPSHIRE:** Kingston, IX-21-1994 (larva). **OHIO:** Hocking St. For., Hocking Co., IX-19-1995 (larva). **TEXAS:** New Waverly, X-6-2001, (♂, 2 ♀, pupae, em. IV-2002). **VIRGINIA:** Huntley Meadows, Fairfax Co., VIII-30-2000 (larvae). **WASHINGTON, DC:** National Arboretum, IX-22-1988 (larvae).

Caryomyia marginata Gagné, new species

Description.—*Gall* (Figs. 139–140): Infrequent, on *Eucarya hickories*; on lower leaf surface, between or on veins; length 3.2–5.0 mm, conical, the base flat against leaf surface, circular, with flattened lip surrounding cone that gradually and evenly narrows to pointed apex; green to tan, smooth, covered evenly with long, sparse hairs not obscuring surface; base with narrow, shallow, circular, central excavation, the leaf without exfoliation surrounding connection; larval chamber ovoid, located at base of gall, surrounded by woody tissue. This conical, sparsely haired gall is most similar to that of *C. conoidea* but the sides of the cone of the *C. marginata* gall are concave and the basal angle is acute and marginate. This gall is entirely woody unlike that of *C. conoidea*, which is partially filled with soft tissue that eventually collapses.

Adult: **Head:** Antenna with 12 flagellomeres; male flagellomeres scarcely binodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose (as in Fig. 242). Palpus 4-seg-

mented. **Thorax:** Wing length 2.0–2.2 mm in male (n=5); 2.6–3.0 mm in female (n=4). **Male abdomen:** Third through seventh tergites each with single row of posterior setae continuous across width; eighth tergite with 0–2 setae laterally. Genitalia: hypoproct broadest near apex, slightly concave posteromedially, margin setose except in concavity, dorsal setulae only on distal third; aedeagus furrowed apically and ventrally; gonostylius narrowed towards apex. **Female abdomen:** Third through eighth tergites each with single row of posterior setae continuous across width, those on eighth tergite sparse and not as long. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (Figs. 211–212): Antennal bases pyramidal, separate, acutely pointed apically. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.3–2.1 (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 309) with long, nearly parallel sided, apically notched tooth and long shaft. Papillae without setae, their bases not raised. Lateral papillae 2–3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded verrucae dorsum at midlength and horizontal rows of spicules on venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Length 0.8–0.9 (n=3). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, elliptical shaft. Bases of dorsal and pleural papillae slightly raised, papillae setose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—**Holotype:** Third instar, from gall on *C. ovata*, Leominster, Massachusetts, IX-21-1994, R.J. Gagné, deposited in USNM.

Etymology.—The name *marginata* is a Latin adjective that refers to the circular, thin lateral margin of the gall.

Affinities.—See under *C. sanguinolenta*, from which this species differs in the shape of the gall.

Collections of galls.—**ALABAMA:** Greenville (*tomentosa*). **ARKANSAS:** Chester (*texana*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Litchfield (*ovata*). **KENTUCKY:** My Old Kentucky Home St. Pk, Nelson Co. (*tomentosa*). **MAINE:** East Lebanon (*ovata*); Eliot (*tomentosa*); North Berwick (*ovata*). **MASSACHUSETTS:** Great Barrington (*ovata*); Leominster (*ovata*). **MISSISSIPPI:** Noxubee Natl Wildlife Ref., Oktibbeha Co. (*tomentosa*). **MISSOURI:** Holly Ridge State For., Stoddard Co. (*tomentosa*). **NEW HAMPSHIRE:** Barrington (*ovata*); Dover (*ovata*); Greenland (*ovata*). **NEW YORK:** Herkimer (*ovata*); Ravena (*ovata*). **OHIO:** St. Clairsville (*tomentosa*); Summerford (*tomentosa*). **ONTARIO:** Dundas (*ovata*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. marginata* examined.—**ARKANSAS:** Chester, IX-9-2004 (larva; 3 ♀, pupae, em. IV-6/9-2005). **MASSACHUSETTS:** Great Barrington, IX-6–2000 (larva); Leominster, IX-21-1994 (larvae; 5 ♂, 4 ♀, pupae, em. IV-1995). **NEW YORK:** Herkimer, IX-4-2003 (larva). **OHIO:** St. Clairsville, IX-6–2004 (larvae); Summerford, IX-9-2004 (larvae). **ONTARIO:** Dundas, VIII-17-1994 (larva). **WEST VIRGINIA:** 6 mi NW Hedgesville, VII-23-2000 & VII-8-2004 (larvae).

Caryomyia melicrustum Gagné, new species

Description.—**Gall** (Figs. 30, 82–83): Common, on *Eucarya* hickories; on lower leaf surface between veins, usually clustered; 2.0–3.0 mm in height, cylindrical, usually slightly wider than long, conical at base, circular, flat to concave at apex; lateral surface tan to brown, shiny, viscid, the apex orange to brown, crusty, thickly mucilaginous; subtending leaf tissue with conspicuous, extensive, irregular exfoliation surrounding base of gall, corresponding top surface of leaf usually discolored, convex; lateral wall of larval chamber firm, brittle, thin laterally, apical wall usually thicker, larval chamber glabrous, with longitudinal ridges. These galls can sometimes be confused with those of mature, dried *C. flaticrustum* galls, but galls of the latter lack the conspicuous leaf exfoliation surrounding the base of galls of *C. melicrustum*.

Adult (female only): **Head:** Antenna with 12 flagellomeres; flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4

segmented. **Thorax:** Wing length 2.1–2.5 mm (n=3). **Female abdomen:** Third through seventh tergites each with posterior setae in a single row, continuous across width; eighth tergite without posterior setae. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 1.4–2.4 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 287) with anterior tooth narrowing from base to slightly notched apex, shaft wide anteriorly, tapering abruptly and linear beyond. Papillae without setae, not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments essentially smooth dorsally, occasionally with some verrucae around lateral pairs of dorsal papillae, with fine, pointed spicules on venter anterior to sternal papillae and none posteriorly. Terminal segment shorter than eighth. **Second instar:** Length 0.7–0.9 mm (n=4). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype:* Third instar, from gall on *C. glabra*, Wheaton Park, Maryland, IX-19-1993, R.J. Gagné, deposited in USNM.

Etymology.—The name *melicrustum*, a noun, is formed from the Latin *mel* for honey and *crustum* for tart, with reference to the resinous covering of the tart-like gall.

Affinities.—Galls of this species, short with a conical base set into an encircling leaf socket, are most like those of *C. striolacrustum* except that they are unlined laterally and sticky to the touch. For further remarks, see under *C. flaticrustum*.

Biological notes.—In late May in Central Maryland, one can find young galls not yet completely broken out of the leaf covering and simu-

lating young galls of *C. tubicola* (Fig. 74) and containing first instars. In mid- to late June, galls are full size but still soft and contain first and second instars. In August one can still see green, softer galls with second instars, but also harder, brown galls with third instars. Pupae emerge from a hole in the thinner walls adjacent to the conical base.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*ovata, tomentosa*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata, pallida*). **ARKANSAS:** 3 mi S Harrison (*tomentosa*); Magazine Mt., Logan Co. (*ovata, texana, tomentosa*); 2 mi S DeQueen (*texana, tomentosa*); Rt. 1 at Red River, Little River Co. (*tomentosa*). **CONNECTICUT:** Amston (*ovata*); Meriden (*glabra, ovata*); New Haven (*glabra*); Phoenixville (*ovata*); Plainfield (*ovata*); Southbury (*glabra, tomentosa*); Westchester (*ovata*). **FLORIDA:** Ponce de Leon (*glabra*). **GEORGIA:** Carnesville (*glabra*); 8 km E Fort Valley (*pallida*); Forsyth (*glabra, ovata*); Lizella (*ovata, tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson Lake St. Pk, Carter Co. (*tomentosa*); Morehead (*tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Pennyrite St. Pk, Christian Co. (*glabra, ovata*); Winchester (*laciniosa*). **MAINE:** North Berwick (*ovata*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Brighton (*tomentosa*); Clarksburg (*tomentosa*); College Park (*glabra*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*glabra*); Potomac (*tomentosa*); Ridgely (*tomentosa*); St. Leonard (*tomentosa*); Silver Spring (*glabra, tomentosa*); Snow Hill (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra, tomentosa*). **MASSACHUSETTS:** Great Barrington (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); Wrentham (*ovata*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 193, Choctaw Co. (*glabra, pallida, tomentosa*); Noxubee Natl Wildlife Ref., Oktibbeha Co. (*ovata, tomentosa*); nr. Sessums, Oktibbeha Co. (*ovata*); 7 mi E Starkville (*pallida*). **MISSOURI:** Crowley Ridge Roadside Pk, Stoddard Co. (*glabra, tomentosa*); Holly Ridge State For., Stoddard Co. (*glabra, tomentosa*). **NEW HAMPSHIRE:** Barrington (*ovata*); Dover (*ovata*); Kingston (*ovata*). **NEW JERSEY:** Columbia (*ovata*); Nyack (*tomentosa*); Columbia (*tomentosa*). **NEW YORK:** Saratoga Springs (*ovata*). **NORTH CAROLINA:** Alamance (*tomentosa*); Alberta (*glabra*); Dertches (*glabra*); Fayetteville (*tomentosa*); Gastonia (*tomentosa*); Providence (*glabra, tomentosa*); Rowland (*tomentosa*); Wise (*tomentosa*). **OHIO:** Hocking St. For.,

Hocking Co. (*tomentosa*); Hocking Co. (*ovata*, Wells 1916: Fig. 30). **ONTARIO:** Dundas (*ovata*).

SOUTH CAROLINA: Georgetown (*tomentosa*); Richland Co. (*Carya* sp.). **TENNESSEE:** Gatlinburg (*glabra*, *tomentosa*); Greene Co., I 81, Mile 38.5 (*ovata*, *tomentosa*). **TEXAS:** Daingerfield St. Pk, Morris Co. (*tomentosa*). **VIRGINIA:** Warren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*); Carson (*tomentosa*); Dinwiddie (*glabra*, *tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); Rt. 81, mi. 13.9, Washington Co. (*ovata*). **WASHINGTON, DC:** National Arboretum (*glabra*, *tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); Cooper's Rock St. Pk, Preston Co. (*glabra*); 6 mi. NW Hedgesville (*tomentosa*).

Specimens of *C. melicrustum* examined.—**ALABAMA:** Greenville, X-20-2000 (larva). **CONNECTICUT:** Plainfield, VIII-27-1988 (larvae). **INDIANA:** Spencer Co., IX-20-1995 (larva). **MARYLAND:** Beltsville, USDA Agricultural Research Center, IX-26-1993 & VIII-22-2000 (larvae), & College Park, IX-23-2003 (larvae; 2 ♀, pupae, em. IV-10-2000); Kemp Mill, X-3-1993 (♀, em. IV-26-1994); Lusby, IX-16-2003 (larvae); Ridgely, IX-23-1999 & X-2-2000 (larvae); Silver Spring, IX-17-1999 & IX-12-1999 (larvae); Wheaton, IX-19-1993 (larvae). **NORTH CAROLINA:** Providence, X-18-2000 (larva). **ONTARIO:** Dundas, VIII-17-1995 (larva). **VIRGINIA:** Huntley Meadows Pk, Fairfax Co., VIII-30-2000 (larvae). **WASHINGTON, DC:** National Arboretum, V-24-1994 (larvae). **WEST VIRGINIA:** 6 mi NW Hedgesville, IX-19-1999 (larvae).

Caryomyia ovalis Gagné, new species

Description.—*Gall* (Figs. 110–111): Rare, on *Eucarya* hickories; on lower leaf surface, between veins; 2.7–3.5 mm in height, ovoid to elongate ovoid, usually longer than wide, slightly bilaterally compressed; smooth, shining, hairless, not sticky, green, turning brown; base of gall abruptly tapered to conical pedicel, leaf with short, thick exfoliation at base of gall forming short, tubular socket, with corresponding convexity on opposite leaf surface; walls hard, enclosing two chambers, the basal larval chamber about 1/3 length of gall, ovoid, smooth, longitudinally ridged, the apical false chamber elongate, thicker walled, gradually narrowed to apex. This gall is two-chambered as is that of *C. caminata*, but the walls of the present

galls are thick and shiny, unlike those of *C. caminata* that are brittle, foliaceous, and matte.

Adult and pupa: Unknown.

Larva: **Third instar:** Length 1.7 mm (n=1). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 325) with anterior tooth equilateral, the shaft broadest anteriorly, parallel-sided beyond. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments with verrucae dorsally along mid-length and with horizontal rows of pointed spicules anteroventrally but not posteroventrally. Terminal segment shorter than eighth. **Second instar:** Length 1.1–1.2 mm (n=3). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, slightly wider shaft. Bases of dorsal and pleural papillae not raised, papillae asetose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype:* Third instar, from gall on *C. glabra*, Kemp Mill, Maryland, X-1-2005, R.J. Gagné, deposited in USNM.

Etymology.—The name *ovalis*, a Latin adjective meaning egg-shaped, refers to the general shape of the gall.

Affinities.—No obvious relative of this rare species presents itself. The distinctive gall is most similar to that of *C. inflata*, but taller and much thicker and woodier.

Collections of galls: **MARYLAND:** Kemp Mill (*glabra*); Silver Spring (*glabra*); Spencerville (*tomentosa*).

Specimens of *C. ovalis* examined: **MARYLAND:** Kemp Mill, X-1-2005 (larva); Spencerville, VII-8-2004 (larvae).

Caryomyia persicoidea (Osten Sacken)

Cecidomyia persicoidea Osten Sacken 1862: 193; Felt 1918: 46 (*Caryomyia*).

Description.—*Gall* (Figs. 17, 126–129): Common, found on *Eucarya* hickories; single or clustered, on veins of lower leaf surface; 5.1–9.0 mm in height, spheroidal or conical, base flat against leaf surface, clasping leaf vein, edge around base acute and lobed to obtusely rounded, tissue on apical third eventually collapsing somewhat and becoming furrowed when mature; covered with short, dense, velvety, green, yellow, tan, or red

hair obscuring surface; connection to leaf circular and shallowly concave or flush with leaf; larval chamber located basally, ovoid, lined with yellowish pellicle different in texture from surrounding soft, spongy, green to purple, viscous tissue that partially collapses with age; a bundle of fibers present between apex of larval chamber and gall apex. Galls may be gum-drop shaped to nearly spherical. The uniform covering of dense, short hair is only slightly longer in galls of *C. spherica*, but the latter galls are always spherical, hard and woody, and the larval chamber is located at the very center of the gall.

Adult: **Head:** Antenna with 12 binodal flagellomeres, male flagellomeres (as in Fig. 239) each with definite internode and neck, the circumfila with short loops, their bases widely separated; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella (as in Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 2.9–4.0 mm in male (n=6), 2.9–4.1 mm in female (n=8). **Male abdomen:** Third to eighth tergites each with posterior setae continuous across width in mostly double row laterally, tapering to single row mesad, eighth tergite with 2–3 setal rows laterally. Genitalia (Figs. 256–257): hypoproct widened laterally to curve around sides of aedeagus, posterior margin setose, dorsal surface setulose only on posterior fourth; apex of aedeagus convex; gonostylus broad apically. **Female abdomen:** Third through eighth tergites as for male, setae of eighth tergite may be interrupted mesally but almost as long as on preceding tergite. Ninth segment (Fig. 265) pliable except for wide dorsal sclerite that partly invests cerci, setae sparse laterally and ventrally, mostly longer than cerci. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 2.0–3.1 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 314) with long, nearly parallel-sided, apically notched tooth and long shaft. Papillae without setae, bases not raised. Lateral papillae 2 on

each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded verrucae covering dorsum at mid-length and horizontal rows of spicules present on venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Length 1.0–1.4 mm (n=5). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—**Syntypes:** Three young galls, from *Carya* sp., vic. Washington, DC. Osten Sacken, deposited in USNM.

Etymology.—Osten Sacken (1862) named this species *persicoides*, Latin for peachlike, for the dense short hair covering the gall.

Affinities.—Antennal and male genitalic characters of this species are similar to those of *C. turbanella*. The male antennal flagellomeres are long with definite nodes and internodes. The aedeagus is rounded apically and the hypoproct is expanded laterally to cover the sides of the aedeagus. The ovipositor of the present species (Fig. 265), however, is elongate and the cerci are reduced in size, while in *C. turbanella* the ovipositor is similar to that in Fig. 259, the more common form found in the genus. Galls somewhat resemble those of the *C. sanguinolenta* species group because of their extensive soft tissue and the presence of a pellicle lining the larval chamber. A large difference between their galls is that only the top section of *C. persicoides* and *C. turbanella* galls breaks off over the winter as a unit, while all the soft tissue on the top and sides of the galls of the *C. sanguinolenta* group eventually separates from the brittle pellicle. Also, pupae of *C. persicoides* and *C. turbanella* break out of the side of the gall, while those of the *C. sanguinolenta* group break out of the bottom of the larval chamber. In addition to these differences, adults of the two groups are different enough that it appears soft-tissued galls evolved at least twice in *Caryomyia*.

Biological notes.—Galls of this species seem to be more commonly found in late summer. In central Maryland I occasionally found small galls with first instars beginning in mid-June but the galls seemed more numerous beginning in early August, when I found galls with larvae in first or second instars. Third instars were apparent in late

August and September. Pupae break through the side of the gall. I once noticed a sciarid pupal exuviae sticking out of a hole near the gall's apex; possibly some other organism made the hole.

Collections of galls.—**ALABAMA:** Auburn (*glabra, tomentosa*); Greenville (*tomentosa*). **ARKANSAS:** Beulah (*tomentosa*); Chester (*texana*); Osage (*texana*); Palestine (*ovata*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Harwinton (*ovata*); Meriden (*ovata*); New Haven (*glabra*); Oakville (*ovata*); Phoenixville (*ovata*); Southbury (*tomentosa*). **FLORIDA:** Chattahoochee (*tomentosa*); Gainesville (*glabra, tomentosa*). **GEORGIA:** Carnesville (*glabra*); Forsyth (*glabra*); 8 km E Fort Valley (*pallida*); Lake Park (*glabra*); Lizella (*ovata, tomentosa*). **ILLINOIS:** Dexter (*tomentosa*); Marshall (*tomentosa*); Rock Island (*tomentosa*). **INDIANA:** New Castle (*glabra*). **KENTUCKY:** Brownsville (*tomentosa*). **MARYLAND:** Beaver Dam (*tomentosa*); Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Brighton (*tomentosa*); Clarksburg (*glabra, tomentosa*); Columbia (*glabra*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*tomentosa*); Piney Grove (*ovata*); Potomac (*tomentosa*); Ridgely (*glabra, tomentosa*); Silver Spring (*glabra, tomentosa*); Snow Hill (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra, tomentosa*). **MASSACHUSETTS:** Wrentham (*ovata*). **MISSOURI:** Conway (*ovata, texana*); St. Clair (*tomentosa*); Wildwood (*tomentosa*). **NEW HAMPSHIRE:** Greenland (*ovata*); Kingston (*ovata*). **NEW YORK:** Addison (*glabra*); East Hampton (*Carya sp.*); Herkimer (*ovata*); Ithaca (*ovata*); Ravenna (*glabra, ovata*); Shokan (*glabra*). **NORTH CAROLINA:** Alamance (*tomentosa*); Alberta (*glabra*); Dorchies (*glabra, tomentosa*); Fayetteville (*tomentosa*); Providence (*glabra, tomentosa*); Wise (*tomentosa*). **OHIO:** Hocking St. For., Hocking Co. (*ovata*); Hocking Co. (*glabra, ovata, tomentosa*, Wells 1916: Fig. 17). **OKLAHOMA:** Sallisaw (*tomentosa*). **ONTARIO:** Dundas (*ovata*). **PENNSYLVANIA:** Kirby (*ovata*); Schellsburg (*glabra*). **SOUTH CAROLINA:** Dillon (*tomentosa*); Georgetown (*tomentosa*). **TENNESSEE:** Crossville (*pallida, tomentosa*); Dandridge (*tomentosa*); Dickson (*tomentosa*). **TEXAS:** New Waverly (*texana*). **VIRGINIA:** Carson (*tomentosa*); Dinwiddie (*glabra, tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); Radford (*tomentosa*); Skippers (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra, tomentosa*); Walter Reed Army Medical Center (*tomentosa*); unspecified (types of *C. persicoides*). **WEST VIRGINIA:** 6 mi NW Hedgesville (*ovata*).

Specimens of *C. persicoides* examined.—**CONNECTICUT:** Amston, VIII-27-1997 (larvae). **FLORIDA:** Gainesville, IX-21-2000 (larvae). **GEORGIA:** 8 km E Fort Valley, X-11-1993, J. & R. Payne (larvae); Lizella, X-11-1993, J. & R. Payne (larvae). **KENTUCKY:** Brownsville, IX-21-1995 (larvae). **MARYLAND:** Brighton, X-VIII-1994 (larvae); Gaithersburg, X-4-1994 (larvae); Beltsville, USDA Agricultural Research Center, IX-11-1994 (larvae; 3 ♀, pupae, em. IV-1995), IX-26-1993, VIII-25-2000 & IX-30-2003 (larvae); Gaithersburg, X-4-1994 (larvae); Lusby, IX-16-2005 (♂, ♀, pupae, em. IV-2 to 3-2006); Ridgely, IX-23-1999 (larvae); Silver Spring, IX-22-1993 & X-24-1999 (larvae). **MISSOURI:** Wildwood, IX-8-2004 (larva). **NEW HAMPSHIRE:** Kingston, IX-21-1994 (larvae). **NEW YORK:** Herkimer, IX-4-2003 (larvae). **OHIO:** Hocking St. For., Hocking Co., IX-19-1995 (larvae). **ONTARIO:** Dundas, VIII-17-1995 (larvae). **TEXAS:** New Waverly, X-6-2001 (♂, ♀, em. IV-2002). **WASHINGTON, DC:** National Arboretum, IX-3-1994 (larvae; 2 ♂, 2 ♀, pupae, em. IV-1995), X-3-1995 (3 ♂, 5 ♀, pupae, em. IV-1996), X-13-1997, IX-22-1998, and VII-13-2000 (larvae); Walter Reed Army Medical Center, IX-25-2003 (larvae); X-13-2004 (♂, 2 ♀, em. IV-3-2005). **WEST VIRGINIA:** 6 mi NW Hedgesville, IX-19-1999, X-17-1999 & VIII-20-2000 (larvae).

Caryomyia procumbens Gagné, new species

Description.—**Gall** (Figs. 94–95): Occasional, found on *Eucarya* hickories, but not east of the Appalachians, except in New England; usually found singly, attached to vein on lower leaf surface; 4–6 mm in length, horizontal, elongate, straight, narrowing gradually from rounded base to pointed apex; white, green, to tan, with stiff, sparse white hairs not obscuring surface; base of gall with central conical pedicel in shallow, circular indentation; wall firm, brittle, uniformly thin, larval chamber glabrous with longitudinal ridges following gall axis from leaf vein connection to apex. The gall is generally similar to that of *C. spinulosa*, q.v. for further remarks about similar galls.

Adult and pupa: Unknown.

Larva: **Third instar:** Length 1.8–2.1 (10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 293) with single, almost parallel-sided tooth with shallow notch anteriorly, shaft wide anteriorly, narrowed beyond. Papillae without setae, their

bases not raised. Lateral papillae 2–3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdomen with extensive verrucae on dorsum, particularly at midlength, and with horizontal rows of spicules on venter anterior to sternal papillae and covering posterior third. Terminal segment shorter than eighth. **Second instar:** Length: 0.9 mm (n=1). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not appreciably raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. ovata*, Morgan Co., West Virginia, X-1-2000, R.J. Gagné, deposited in USNM.

Etymology.—The name *procumbens* is a Latin adjective and refers to the procumbent nature of the gall.

Affinities.—See under *C. eumaris*.

Collections of galls.—CONNECTICUT: Danbury (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Thomaston (*ovata*). ILLINOIS: Dexter (*laciniosa*); Marshall (*tomentosa*). INDIANA: Spencer Co. (*ovata*). KENTUCKY: My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Pennyrite St. Pk, Christian Co. (*ovata*); Winchester (*laciniosa*). MISSISSIPPI: Natchez Trace Pkwy, Mile 193, Choctaw Co. (*tomentosa*); Noxubee Natl Wildlife Refuge, Oktibbeha Co. (*tomentosa*). MISSOURI: Wildwood (*tomentosa*). OHIO: Summerford (*tomentosa*). PENNSYLVANIA: Mooresville (*tomentosa*). TENNESSEE: Greene Co., I 81, Mile 38.5 (*tomentosa*). WEST VIRGINIA: Beech Fork St. Pk, Wayne Co. (*tomentosa*); Cacapon (*tomentosa*); 6 mi NW Hedgesville (*glabra, ovata*).

Specimens of *C. procumbens* examined.—ILLINOIS: Marshall, IX-7-2004 (larva). INDIANA: Spencer Co., IX-20-1995 (larvae). KENTUCKY: Winchester, IX-22-1995 (larvae). OHIO: Summerford, IX-7-2004 (larvae). WEST VIRGINIA: 6 mi NW Hedgesville, IX-12-1999, VII-8-2000, & X-3-2003 (larvae); Morgan Co., X-1-2000 (larva).

Caryomyia purpurea Gagné, new species

Description.—*Gall* (Figs. 15, 120–122): Common, found on *Eucarya hickories*; on lower leaf surface, usually found in groups between veins but may occur close to veins; 2.2–3.0 mm in height, spheroidal, occasionally with slight, conical prominence at apex, surface covered with

long, thick, mostly dark brown hair obscuring gall surface; base with deep, circular, central excavation, the leaf without exfoliation surrounding connection; wall woody, of even thickness but thicker apically if peak present, green to brown; larval chamber at base of gall ovoid, violet to purple. Externally, the more conical galls are similar to the more short-conical galls of *C. holotricha*; such galls must be cut open to see whether hairs intrude into the larval chamber from the apex as they do in galls of *C. holotricha*.

Adult: **Head:** Antenna with 12 flagellomeres; each of male flagellomeres (as in Fig. 239) binodal with definite internode and neck, circumfila with short loops, their bases widely separated; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. **Thorax:** Wing length 3.1–3.4 mm in male (n=5), 2.5–3.5 mm in female (n=5). **Male abdomen:** Third through eighth tergites each with posterior setae continuous across width in mostly single row, occasionally in partly double row, the line broken for short distance mesally; eighth tergite not more weakly sclerotized than seventh, the setae as long. Genitalia (Figs. 254–255): hypoproct nearly parallel sided, deeply concave posteromesally, posterior margin setose except in concavity; apex of aedeagus convex. **Female abdomen:** Third through eighth tergites each with posterior setae continuous across width in mostly single row, occasionally in partly double row, the line broken for short space mesally; eighth tergite not more weakly sclerotized than seventh, the setae as long. Ninth segment pliable except for fairly wide dorsal sclerite, setae long but sparse. Cerci elongate-ovoid, pointed apically, pigmented, fused dorsally on basal third.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.8–2.2 mm (n=10). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 306) with parallel-sided apically-notched apical tooth, the space in notch erose in some specimens, and elongate, narrow shaft.

Papillae without setae, their bases not raised. Lateral papillae numbering 2–3 on each side of spatula. Only 4 dorsal papillae present on first 7 abdominal segments. Abdominal segments with verrucae along midlength of dorsum and horizontal rows of spicules anterior to sternal papillae on venter and also posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Length 0.9–1.3 mm (n=4). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae setose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. glabra*, Beltsville, Maryland, IX-28-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *purpurea* is a Latin adjective meaning purple, with reference to the color of the larval chamber walls.

Affinities.—This species differs from others, such as *C. tuberculata* and *C. holotricha*, which also have long male flagellomeres, an apically rounded aedeagus, and a deep, circular, basal excavation of the gall, but the larva of the present species has a notched spatula and the first though seventh abdominal segments each have only four dorsal papillae. The other two species have a triangular spatula tooth and six dorsal abdominal papillae.

Collections of galls.—**ALABAMA:** Auburn (*ovata, tomentosa*); Greenville (*tomentosa*). **ARKANSAS:** Piney (*texana*). **CONNECTICUT:** Danbury (*ovata*); Oakville (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Southbury (*tomentosa*); Thomaston (*ovata*); Westchester (*ovata*). **GEORGIA:** Forsyth (*glabra*); 8 km E Fort Valley (*pallida*). Lake Park (*glabra*). **ILLINOIS:** Dexter (*laciniosa, tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Brighton (*tomentosa*); College Park (*glabra*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*glabra, tomentosa*); Ridgely (*glabra, tomentosa*); Silver Spring (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra, tomentosa*). **MASSACHUSETTS:** Great Barrington (*ovata*). **MISSOURI:** Conway (*texana*); Rolla (*texana*); St. Clair (*tomentosa*). **NEW HAMPSHIRE:** Kingston (*ovata*). **NEW JERSEY:** Columbia (*glabra, tomentosa*). **NEW YORK:** E. Schodack (*Carya* sp.); Hyde Park (*ovata*); New York (*Carya* sp.). **NORTH CAROLINA:** Alamance (*glabra, tomentosa*); Fayetteville (*tomentosa*); Providence (*glabra, tomentosa*); Wise (*tomentosa*). **OHIO:** Hocking Co.

(*tomentosa*, Wells 1916: Fig. 15); Yellow Springs (*glabra*). **ONTARIO:** Dundas (*ovata*). **SOUTH CAROLINA:** Georgetown (*tomentosa*). **TENNESSEE:** Crossville (*pallida*); Dickson (*tomentosa*). **VIRGINIA:** Dinwiddie (*glabra, tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra, tomentosa*); Rock Creek Park (*ovata*); Walter Reed Army Medical Center (*tomentosa*).

Specimens of *C. purpurea* examined.—**CONNECTICUT:** Phoenixville, IX-20-1994 (larvae). **GEORGIA:** 8 km E Fort Valley, IX-11-1993, J. & R. Payne (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, X-5-1994 & IX-28-1999 (larvae); Brighton, X-8-1994 (larvae; 3 ♂, 4 ♀, em. IV-1995); Ridgely, IX-23-1999 (larvae), X-2000 (3 ♂, em. IV-2001); Gaithersburg, X-4-1994 (larvae; 2 ♀, pupae, em. IV-1995); Silver Spring, X-3-1993 (larvae; 10 ♂, 9 ♀, pupae, em. IV-26-1994); Spencerville, IX-22-2003 (larvae; ♀, em. IV-14-2004); Wheaton, IX-19-1993 & X-13-1999 (larvae). **MISSOURI:** Conway, IX-8-2004 (larvae). **NEW HAMPSHIRE:** Kingston, IX-21-1994 (larvae). **OHIO:** Yellow Springs, IX-7-2004 (larvae). **ONTARIO:** Dundas, VIII-17-1995 (larvae). **WASHINGTON, DC:** National Arboretum, X-3-1994 (larvae); Walter Reed Army Medical Center, X-7-1993 (larvae; 3 ♂, 3 ♀, pupae, em. IV-23-26-1994), X-2005 (larvae; pupae, 5 ♂, 26 ♀, em. III-28 to IV-15-2006).

Caryomyia recurvata Gagné, new species

Description.—*Gall* (Figs. 9, 90–91): Occasional, found on *Eucarya* hickories; usually in groups, on lower leaf surface on vein; 2.5–4.0 mm in length, recumbent, truncate near base, abruptly narrowed and recurved beyond basal third; white, green, to tan, hairless, glaucous; base of gall with central, conical pedicel surrounded by shallow, circular indentation; wall firm, brittle, uniformly thin except for slightly thicker blunt end, larval chamber glabrous, with longitudinal ridges following gall axis from leaf vein connection to recurved apex. This gall is most similar to that of *C. eumaris* but is hairless and has a smooth glaucous surface and has a more truncate base. The gall of *C. eumaris* has a rough and sparsely hairy surface.

Adult (male only): Head: Antenna with 12 flagellomeres; male flagellomeres (as in Fig. 237) scarcely binodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length. Labella (as in Fig. 242) separated

from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 1.5 mm (n=1). **Male abdomen:** Third through seventh tergites each with posterior setae continuous across width, in single row; eighth tergite weakly sclerotized, with 3 posterior setae laterally. Genitalia: gonostylus gradually narrowed from base to apex, the tooth relatively narrow; hypoproct broadest near apex with slight concavity posteromesally, apical margin setose except in concavity, dorsal setulae present only on distal third; aedeagus furrowed apically and ventrally.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.6–2.2 mm (n=7). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 294) with nearly parallel-sided, shallowly notched anterior tooth, the shaft widest anteriorly, tapering beyond. Papillae without setae, their bases not raised. Lateral papillae 2–3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdomen with extensive verrucae on dorsum, particularly at midlength, and with horizontal rows of spicules on venter anterior to sternal papillae and covering posterior third. Terminal segment shorter than eighth. **Second instar:** Length 0.8 mm (n=1). Collar segment with patch of enlarged spicules on each side. Spatula with large, apically pointed tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not appreciably raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—**Holotype:** Third instar, from gall on *C. glabra*, National Arboretum, Washington, DC, IX-23-1988, R.J. Gagné, deposited in USNM.

Etymology.—The name *recurvata* is a Latin adjective referring to the recurved neck of the gall.

Affinities.—See under *C. eumaris*.

Collections of galls.—**ALABAMA:** Auburn (*glabra*, *pallida*). **ARKANSAS:** Magazine Mt., Logan Co. (*tomentosa*); 2 mi S DeQueen (*tomentosa*); Rt.1 at Red River, Little River Co. (*tomentosa*). **CONNECTICUT:** Phoenixville (*ovata*); Westchester (*ovata*). **ILLINOIS:** Dexter (*tomentosa*); Marshall (*tomentosa*).

KENTUCKY: Grayson Lake St. Pk, Carter Co. (*tomentosa*); Pennyrite St. Pk, Christian Co. (*glabra*, *ovata*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Ridgely (*tomentosa*); Snow Hill (*tomentosa*). **MISSISSIPPI:** Noxubee Natl Wildlife Ref., Oktibbeha Co. (*ovata*, *tomentosa*). **OHIO:** Hocking Co. (*ovata*, Wells 1916: Fig. 9). **MISSOURI:** Conway (*ovata*, *texana*); Holly Ridge State For., Stoddard Co. (*tomentosa*); St. Clair (*tomentosa*); Wildwood (*tomentosa*). **TENNESSEE:** Dickson (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra*).

Specimens of *C. recurvata* examined.—**MARYLAND:** Beltsville, USDA Agricultural Research Center, X-5-1994 & VII-1-2000 (larvae); Ridgely, IX-23-1999 (larvae). **MISSOURI:** Conway, IX-8-2004 (♂, pupae, em. IV-9-2005); Wildwood, IX-8-2004 (larvae). **WASHINGTON, DC:** National Arboretum, IX-22-1988 (larva).

Caryomyia sanguinolenta (Osten Sacken)

Cecidomyia sanguinolenta Osten Sacken 1862: 192; Felt 1909: 293 (*Caryomyia*).

Description.—**Gall** (Figs. 10, 134–136): Common, found on *Eucarya hickories*; single or clustered, on lower leaf surface between veins; height 1.9–4.1 mm, conical, basal edge flared, acute or rounded, the base adjacent to leaf either flat or convex, the central part of the base permanently hard and differing in texture from softer outer part (Fig. 136), lateral sides of cone in profile convex at first, becoming concave, then furrowed upon further drying, the apex obtuse to acute; hairless, green, turning brown, crimson, or purple, not sticky; base with shallow, circular, central excavation, the leaf without exfoliation around connection; larval chamber ovoid, located at base of gall, surrounded by yellowish pellicle different in texture from the soft, large-celled usually purple tissue beyond that partly collapses with age; a bundle of fibers present between apex of larval chamber and gall apex. Galls of *C. sanguinolenta* and *C. conoidea* are most similar to one another in shape, but that of *C. conoidea* bears short, rigid, sparse hairs.

Adult: **Head:** Antenna with 12 flagellomeres; male flagellomeres (as in Fig. 237) scarcely binodal, only slightly narrowed beyond basal circum-

filum, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella (as in Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 1.7–2.1 mm in male (n=5); 2.1–2.7 mm in female (n=4). **Male abdomen:** Third through seventh tergites each with posterior setae continuous across width, in single row; eighth tergite weakly sclerotized, without posterior setae. Genitalia (as for Figs. 247–248): gonostylus gradually narrowed from base to apex, the tooth relatively narrow; hypoproct broadest near apex with slight concavity posteromesally, margin setose except in concavity, dorsal setulae present only on distal third; aedeagus furrowed apically. **Female abdomen:** Third through eighth tergites each with posterior setae continuous across width, in mostly single row, usually double at lateral limits; eighth tergite not less sclerotized than seventh, setae nearly as long. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva (Figs. 220–222): **Third instar:** Length 18–25 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 303) with long, nearly parallel sided, apically notched tooth and long shaft. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Four dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded and pointed verrucae covering dorsum extensively across midlength and with horizontal rows of pointed spicules across venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Length 0.8–1.2 mm (n=8). Collar segment with patch of enlarged spicules on each side. Spatula present, with acutely triangular anterior tooth and elliptical shaft. Dorsal and pleural papillae not appreciably raised, about as long as wide, without setae. Four dorsal papillae on first 7 abdominal segments.

Type material.—Neotype: The original Osten Sacken syntypes, larva(e) and galls collected from *Carya* sp. in the vicinity of Washington, DC, are presumed lost. They were not found in either the MCZ or the USNM. A neotype is designated here, a third instar (right hand specimen of two on a slide) from galls fitting Osten Sacken's original description, *Carya tomentosa*, Walter Reed Army Medical Center Annex, Silver Spring, Maryland, X-24-1999, R.J. Gagné, deposited in the USNM. The galls from which the neotype and the other associated larva were taken are also preserved in the USNM.

Etymology.—The name *sanguinolenta* is an adjective from the Latin meaning blood red, coined by Osten Sacken with reference to the crimson to purple external color of most mature galls of this species.

Affinities.—Galls of this species resemble closely enough those of several other species, *C. biretta*, *C. conoidea*, *C. lunata*, *C. marginata*, and *C. stellata*, to indicate some relationship among them, given other similarities of adult and larval characters. These species differ only in the shape of their galls, which are conical with their extensive soft, large-celled tissue eventually collapsing. Between that tissue and the larval cell is a pellicle that is at first soft but eventually hardens into a brittle covering. The soft tissue mostly deteriorates during the winter. The base of the galls, through which pupae eventually escape, is shield-like and smooth, even on otherwise hairy galls. The conical galls only superficially resemble those of *C. persicoides* and *C. turbanella*. Galls of these last two deteriorate differently and pupae break out of the side of the gall rather than the base. Also, the male antennae and genitalia of these two species place them in another group.

Biological notes.—Tiny, green, occasionally red galls with first instars were found as early as mid-May in the Washington, DC area. By mid-June, both small and full-size galls were present with first and second instars, respectively. Small galls with first instars could still be found as late as early August, although the preponderance of galls found after mid-July contained second instars. Third instars were found beginning in early August and by late August most galls contained third instars. Galls remain on leaves until leaf drop in October. Many galls are red or purple by autumn but some remain green. Pupae escape through a hole made in the base of the gall, to the side of the central, harder part (Fig. 136).

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*glabra, ovata, pallida*); Oak Mt. St. Pk, Shelby Co. (*pallida*). **ARKANSAS:** 3 mi S Harrison (*tomentosa*); Magazine Mt., Logan Co. (*ovata, tomentosa*); Piney (*texana*). **CONNECTICUT:** Amston (*ovata*); Meriden (*glabra, ovata*); New Haven (*glabra*); Pachaug St. Pk (*ovata*); Phoenixville (*ovata*); Southbury (*tomentosa*); Westchester (*ovata*). **FLORIDA:** Chattahoochee (*tomentosa*); Gainesville (*tomentosa*). **GEORGIA:** Carnesville (*glabra*); Forsyth (*glabra, ovata*); Fort Valley (*pallida*); Lake Park (*glabra*); Lizella (*ovata*). **ILLINOIS:** Dexter (*tomentosa*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson Lake St. Pk, Carter Co. (*tomentosa*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*texana*). **MARYLAND:** Beaver Dam (*tomentosa*); Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Brighton (*tomentosa*); Calverton (*tomentosa*); Clarksburg (*glabra, tomentosa*); College Park (*glabra*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*glabra, tomentosa*); Potomac (*tomentosa*); Ridgely (*glabra, tomentosa*); St. Leonard (*tomentosa*); Silver Spring (*glabra, tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra, tomentosa*). **MASSACHUSETTS:** Bolton (*ovata*); Merrimac (*ovata*); Wrentham (*ovata*). **MISSOURI:** Holly Ridge State For., Stoddard Co. (*glabra*). **NEW HAMPSHIRE:** Kingston (*ovata*). **NEW JERSEY:** Columbia (*tomentosa*). **NEW YORK:** Central Pk, New York (*tomentosa*); Ravenna (*glabra, ovata*); Skokan (*glabra*). **NORTH CAROLINA:** Alamance (*tomentosa*); Alberta (*glabra*); Fayetteville (*tomentosa*); Kannapolis (*tomentosa*); Providence (*glabra, tomentosa*); Rowland (*tomentosa*); Wise (*tomentosa*). **OHIO:** Gypsum (*glabra*, Wells 1916, Fig. 10). **ONTARIO:** Dundas (*ovata*). **PENNSYLVANIA:** Millsboro (*glabra*); Schellsburg (*glabra, ovata*). **TENNESSEE:** Dandridge (*tomentosa*); Lebanon (*glabra*). **VIRGINIA:** Carson (*tomentosa*); Leesburg (*tomentosa*); Skippers (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra, tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); Cacapon (*ovata*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. sanguinolenta* examined.—**ARKANSAS:** Piney, IX-10-2004 (larva). **CONNECTICUT:** New Haven, IX-19-1994 (larva); Phoenixville, IX-20-1994 (larvae). **GEORGIA:** Lizella, X-12, 1993, J. & R. Payne (larva). **ILLINOIS:** Dexter, IX-8-2004 (larvae). **KENTUCKY:** Brownsville, IX-21-1995 (larva); Grayson Lake St. Pk, Carter Co., IX-22-1995 (larva). **MARYLAND:** Beltsville, USDA Agricultural Research Center, I-7-2000 (larvae); Brighton, X-

10-1993 (2 ♂, ♀, pupae, em. IV-25-28-1993); Calverton, X-10-2005 (♂, 5 ♀, pupa & pupal exuviae, em. III-30 to IV-15-2006); College Park, IX-23-2003 (2 ♂, 2 ♀, pupae, em. IV-10-2004); Ellicott City, IX-2-2000 (larvae); Gaithersburg, X-4-1994 (larvae); Lusby, IX-16-2003 (larvae); Ridgely, IX-23-1999 (larvae); Silver Spring, IX-14-1993, IX-17-1993, IX-22-1993, and X-24-1999 (larvae); Wheaton, IX-19-1999 (larvae). **WASHINGTON, DC:** National Arboretum, X-3-1994 (larva); Walter Reed Army Medical Center, IX-2000 (larvae; ♂, 3 ♀, pupae, em. IV-2001). **WEST VIRGINIA:** 6 mi NW Hedgesville, X-17-1999 (larvae).

Caryomyia shmoo Gagné, new species

Description.—**Gall** (Figs. 59–61): Common, found on *Eucarya hickories*; single or clustered, on lower leaf surface between veins; 2.5–3.5 mm in height, bilaterally symmetrical, truncate-spheroidal at base, apical third abruptly narrowed, set to one side, and tipped with an umbo; green to yellow, turning tan to brown, smooth, hairless, not sticky; base with prominent conical pedicel set into circular indentation, leaf without conspicuous exfoliation surrounding base of gall; wall firm, brittle, thin, larval chamber shaped as for gall, glabrous, with longitudinal ridges. This gall resembles most that of the related species, *C. caryae*. The gall of the latter is spheroidal but that of *C. shmoo* is conspicuously narrowed at its apical third.

Adult: **Head:** Antenna with 12 flagellomeres, in male with additional short 13th flagellomere without circumfila; each of regular 12 male flagellomeres (as for Fig. 239) binodal with definite internode and neck, circumfila with short loops, their bases widely separated; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. **Thorax:** Wing length 2.7–3.6 mm in male (n=2), 3.0–3.1 mm in female (n=2). **Male abdomen:** Third through eighth tergites each with posterior setae separated into 2 lateral groups, in 1 to 3 horizontal rows; eighth tergite not more weakly sclerotized than seventh. Genitalia: hypopyroct nearly parallel sided, weakly concave posteromesally, the margin partly setose, dorsum setulose only on distal third; apex of aedeagus convex. **Female abdomen:** Third through seventh tergites each with posterior setae as for male; eighth tergite more weakly sclerotized than preceding tergite, with posterior setae only laterally

and not as long as on preceding tergite. Ninth segment pliable except for dorsal sclerite that widens from base to apex, setae sparse laterally and ventrally, many longer than cerci. Cerci ovoid in lateral view, fused dorsally for about 2/3 length.

Pupa (Figs. 201–202): Antennal bases oblique in ventral view, converging and narrowing anteriorly, their rounded apices closely adjacent. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 1.8–2.4 mm (n=10). Body ovoid-cylindrical, anterior end more broadly rounded than posterior end. Head directed ventrally. Spatula (Fig. 284) with 2 widely separated anterior teeth, the space between concave, shaft widest anteriorly, narrowing abruptly before posterior half, parallel-sided beyond. Papillar bases moderately raised, dorsals and pleurals with setae, also ventrals with setae on first through seventh abdominal segments. Lateral papillae 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Body entirely covered with verrucae laterally and dorsally and with spicules covering venter. Terminal segment as long as eighth. **Second instar:** Length 0.8–1.2 mm (n=5). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider concave-sided shaft. Bases of dorsal and pleural papillae raised and all short-setose including on prothorax. Six dorsal papillae on first 7 abdominal segments.

Type material.—**Holotype:** Third instar, left specimen on slide mount, from gall on *C. glabra*, Wheaton, Maryland, IX-19-1993, R.J. Gagné, deposited in USNM.

Etymology.—The name *shmoo* is a noun in apposition. The shape of this gall is reminiscent of one of the benevolent and irrepressible organisms with that name created in 1948 by Al Capp for his comic strip, *Li'l Abner*.

Affinities.—This species forms a natural group with *C. caryae* and *C. hirtiglobus* because of the general shape of the gall and the similarity of the larvae, particularly the two widely separated anterior teeth of the third instar spatula. As with *C. hirtiglobus* but not *C. caryae*, the dorsal and pleural papillae of the larval prothorax are setose. *C. shmoo* differs from *C. hirtiglobus* in the apices of the pupal antennal horns being separated instead

of closely adjacent and the larval spatula teeth separated from one another by a distance shorter than their length. See under *C. caryae* for further discussion.

Biological notes.—Soft, whitish-green galls were first noted in central Maryland on June 9 and contained first instars. On June 15, full grown galls were brittle and still contained first instars. By July 8, galls contained second and third instars. When full-grown, the white larva fills the entire larval chamber and is very active when disturbed. Pupae exit the gall from one side through which the larva has already scraped away part of the wall.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*glabra*, *ovata*, *pallida*, *tomentosa*); Greenville (*tomentosa*). **ARKANSAS:** Chester (*texana*); 2 mi S DeQueen (*texana*, *tomentosa*); Piney (*texana*); Rt.1 at Red River, Little River Co. (*tomentosa*). **CONNECTICUT:** Hartland (*ovata*); Meriden (*ovata*); Phoenixville (*ovata*); Southbury (*glabra*). **FLORIDA:** Gainesville (*glabra*, *tomentosa*); Chattahoochee (*tomentosa*). **GEORGIA:** 8 km E Fort Valley (*ovata*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*texana*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra*, *tomentosa*); Clarksburg (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*tomentosa*); Ridgely (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 123, Rankin Co. (*glabra*, *pallida*, *tomentosa*); Natchez Trace Pkwy, Mile 193, Choctaw Co. (*tomentosa*); 7 mi E Starkville (*tomentosa*). **MISSOURI:** Conway (*texana*); Mark Twain Natl For. (*tomentosa*); St. Clair (*tomentosa*). **NEW HAMPSHIRE:** Kingston (*ovata*). **NEW YORK:** Shokan (*glabra*); Saratoga Springs (*ovata*). **NORTH CAROLINA:** Fayetteville (*tomentosa*). **OHIO:** Yellow Springs (*glabra*). **PENNSYLVANIA:** Schellsburg (*ovata*). **SOUTH CAROLINA:** Georgetown (*tomentosa*). **TEXAS:** New Waverly (*tomentosa*). **VIRGINIA:** Dinwiddie (*tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*tomentosa*). **WEST VIRGINIA:** Cacapon (*ovata*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. shmoo* examined.—**ALABAMA:** Greenville, IX-21-2000 (2 ♂, pupae, em. IV-2001). **GEORGIA:** 8 km E Fort Valley, X-11-1993, J. & R. Payne (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, IX-26-1993 & X-5-1994 (larvae); Gaithersburg, VII-20-2000 (larva); Lusby, IX-16-2003 (larvae); Ridgely, IX-23-1999 (larva); Spencerville, IX-4 & 21-2003 (larvae; ♀, pupa, em. IV-2004); Wheaton, IX-19-1993 (larvae). **NEW**

HAMPSHIRE: Kingston, IX-2-1994 (larva). **NEW YORK:** Saratoga Springs, IX-25-1994 (larvae). **OHIO:** Yellow Springs, IX-7-2004 (larvae). **TEXAS:** New Waverly, X-6-2001 (♀, pupae, em. IV-2002). **WASHINGTON, DC:** National Arboretum, IX-21-2003 (larvae).

Caryomyia spherica Gagné, new species

Description.—**Gall** (Figs. 21, 160–161): Infrequent, on *Eucarya hickories*; usually scattered along veins, on lower leaf surface; 5.0–8.0 mm in diameter, spherical, covered with thick, short, brown hair obscuring gall surface; base with narrow, shallow, circular depression; larval chamber at center of sphere, ovoid, tan to brown, the surrounding thick walls large-celled, woody. Galls of this species are superficially similar to the rounder galls of *C. persicoides*, but the larval chamber of *C. spherica* is centrally located instead of at the base of the gall. The gall is also much harder and not subject to shrinkage as is the softer gall of *C. persicoides*.

Adult: Head: Antenna with 12 flagellomeres and a short apical bud on the 12th; the regular 12 male flagellomeres almost evenly cylindrical, slightly narrowed from base to apex, circumfila loops short, subequal in length; female flagellomeres with circumfila anastomosing on venter. Labella (Fig. 244) discrete, ovoid, with many long setae and covered with setulae. Palpus (Fig. 244) 1–2 segmented. Labella separate with several robust setae. **Thorax:** Wing length 3.3–3.5 mm in male (n=2); 4.1–4.2 mm in female (n=2). **Male abdomen:** Third through seventh tergites each with posterior setae continuous across width, 3–4 rows laterally, diminishing to 1–2 rows mesally; eighth tergite with 0–3 posterolateral setae. Genitalia: hypoproct broadest near apex, slightly bilobed at apex, the lobes rounded; apex of aedeagus weakly furrowed. **Female abdomen:** Third through seventh tergites each with posterior setae continuous across width, in mostly 4 rows laterally, tapering to 2–3 rows mesally; eighth tergite with mostly double row of posterior setae laterally, diminishing to 0–1 rows mesally, and shorter than setae on previous tergite. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (Figs. 205–206): Antennal bases oblique in ventral view, converging anteriorly, each termi-

nating in prominent, closely adjacent point. Face with anterolateral pair of horizontal incisions, their posterior lip slightly protruding. Frons and clypeus moderately protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 2.3–4.2 mm (n=5). Body ovoid, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 317) with tapered, apically-pointed tooth and long shaft widened at both ends. Dorsal and pleural papillae with short setae; bases of papillae not raised. Lateral papillae 2–3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments with verrucae covering most of dorsum and with horizontal spicule rows anteriorly and posteriorly on venter. Terminal segment shorter than eighth. **Second instar:** Length 1.4–1.5 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with elongate, acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae raised, papillae with setae. Six dorsal papillae on first 7 abdominal segments.

Type material.—**Holotype:** Third instar, middle of 3 specimens on slide, from gall on *C. tomentosa*, Beltsville Agricultural Research Center, Beltsville, Maryland, IX-30-2003, R.J. Gagné, deposited in USNM.

Etymology.—The name *spherica* is a Latin adjective, referring to the spherical gall.

Affinities.—Among the *Caryomyia* species with foreshortened male flagellomeres and furrowed aedeagus, this species stands alone for the one or two instead of four-segmented palpi and the strongly instead of weakly setose labella. Galls of *C. spherica* and the more spherical galls of *C. persicoides* can be superficially similar in gross aspect. Larvae of *C. spherica* have a triangular apical tooth on the spatula and setose dorsal and pleural papillae and the adult has a 1–2 segmented palpus; in *C. persicoides*, the larva has a parallel-sided, notched tooth and asetose papillae and the adult has a 4-segmented palpus.

Biological notes.—In autumn the full-grown larva cuts a cylindrical passage from its chamber in the center of the gall up to but not including the epidermis. In spring the pupa pushes through the epidermis. Adults were reared in early April. In my experience this gall appears in late summer.

Collections of galls.—**ALABAMA:** Auburn (*glabra*, *pallida*, *tomentosa*); Greenville (*tomentosa*).

CONNECTICUT: Meriden (*ovata*); Southbury (*tomentosa*). **FLORIDA:** Chattahoochee (*tomentosa*). **GEORGIA:** Forsyth (*ovata*); Lizella (*tomentosa*). **ILLINOIS:** Highland (*laciniosa*); Rock Island (*Carya* sp., B.D. Walsh). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Ridgely (*tomentosa*). **MISSISSIPPI:** Starkville (*tomentosa*). **NORTH CAROLINA:** Alamance (*tomentosa*); Fayetteville (*tomentosa*); Gastonia (*tomentosa*); Providence (*tomentosa*). **Ohio:** Unspecified (*ovata*, Wells 1916: Fig. 21). **TENNESSEE:** Crossville (*pallida*); Jackson (*tomentosa*). **TEXAS:** New Waverly (*tomentosa*). **VIRGINIA:** Dinwiddie (*tomentosa*).

Specimens of *C. spherica* examined.—**GEORGIA:** Lizella, X-12-1993, J. & R. Payne (larvae). **ILLINOIS:** Highland, IX-8-2004 (larvae); Rock Island, B.D. Walsh (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, IX-30-2003 (larvae; 2 ♂, pupae, em. IV-12-2004); Ridgely, IX-23-1999 (larvae; 2 ♀, em. IV-2000). **NORTH CAROLINA:** Gastonia, IX-18-2000 (larvae). **TENNESSEE:** Crossville, IX-11-2004 (larva). **TEXAS:** New Waverly, X-6-2001 (larva; ♀, em. IV-2002).

Caryomyia spiniglobus Gagné, new species

Description.—**Gall** (Fig. 64–65): Common, on *Eucarya* hickories; single or in groups on lower leaf surface between veins; 2.8–3.5 mm in height, spherical with a conspicuous apical terminus made up of a nipple atop an abruptly raised areola; green to yellow, becoming tan to brown with widely spaced, short, stiff light brown hairs not obscuring surface; base with small conical pedicel, leaf without exfoliation; wall firm, brittle, uniformly thin, larval chamber glabrous with longitudinal ridges. This gall differs from that of *C. leviglobus* in that it has hair. Both galls are distinctive for the raised apical knob.

Adult: **Head:** Antenna with 12 flagellomeres; each of the 12 male flagellomeres (as in Fig. 238) scarcely binodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length, basal node with almost no setulae, distal node evenly setulose; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. **Thorax:** Wing length 1.7 mm in male (n=1); 2.0 mm in female (n=1). **Male abdomen:** Third through seventh tergites each with single row of posterior setae nearly continuous across width except inter-

rupted mesally; eighth tergite without posterior setae. Genitalia: hypoproct broadest before posterior convex margin, margin setose; aedeagus evenly cylindrical, wide, notched apically. **Female abdomen:** Third through seventh tergites each with single row of posterior setae nearly continuous across width except interrupted mesally; eighth tergite as sclerotized as preceding tergite, with single row of posterior setae only laterally, the setae not as long as on seventh tergite.

Pupa: Unknown.

Larva: **Third instar:** Length: 1.7–2.5 mm (n=10). Body spindleform, segments convex, head end tapered, posterior end rounded. Head ventral. Spatula (as in Fig. 281) with large, simple anterior tooth nearly as long as broad shaft. All papillae except terminals setose, papillar bases not conspicuously raised. Lateral papillae 2 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments completely covered with raised, pointed verrucae. Terminal segment as long as eighth. **Second instar:** Not seen.

Type material.—**Holotype:** Third instar, from gall on *C. tomentosa*, vic. Ridgely, Caroline Co., Maryland, R.J. Gagné, IX-23-1999, deposited in USNM.

Etymology.—The name *spiniglobus* is a noun formed from the Latin *spina* (spine) and *globus* (globe), with reference to the erect-haired spherical gall.

Affinities.—See under *C. leviglobus*, from which the present species differs only in the hairy galls.

Biological notes.—Tiny, soft, whitish galls with first instars were first noted in central Maryland on June 9. In mid-June to mid-July soft galls could be found mixed with hard, brittle galls, the former with first, the latter with second instars. By beginning of August galls were regularly found with third instars. Feeding larvae lie prone against the concave surface of the larval chamber.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*tomentosa*); Greenville (*tomentosa*). **ARKANSAS:** 2 mi S DeQueen (*tomentosa*); Palestine (*ovata*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Hartland (*ovata*); Phoenixville (*ovata*). **FLORIDA:** Chattahoochee (*tomentosa*); Gainesville (*tomentosa*); Lake City (*tomentosa*). **GEORGIA:** Lizella (*tomentosa*). **KENTUCKY:** My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Morehead (*tomentosa*); Pennyrite St. Pk, Christian Co.

(*ovata*); Winchester (*laciniosa*). LOUISIANA: Lake Bistineau St Pk, Webster Parish (*tomentosa*). MARYLAND: Beltsville, USDA Agricultural Research Center (*tomentosa*); Calverton (*tomentosa*); Clarksburg (*tomentosa*); Ellicott City (*tomentosa*); Lusby (*tomentosa*); Ridgely (*tomentosa*). MASSACHUSETTS: Petersham (*ovata*). MISSISSIPPI: Natchez Trace Pkwy, Mile 193, Choctaw Co. (*glabra, tomentosa*); Noxubee Natl Wildlife Ref., Oktibbeha Co. (*tomentosa*); 7 mi E Starkville (*tomentosa*). NEW JERSEY: Columbia (*ovata*). NEW YORK: Ithaca (*ovata*). PENNSYLVANIA: Julian (*glabra*); Pavia (*ovata*); Schellsburg (*ovata*). SOUTH CAROLINA: Dillon (*tomentosa*). Georgetown (*tomentosa*). TENNESSEE: Dickson (*tomentosa*); Greene Co., I 81, Mile 38.5 (*tomentosa*); Gatlinburg (*tomentosa*). VIRGINIA: Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Radford (*tomentosa*). WASHINGTON, DC: National Arboretum (*tomentosa*). WEST VIRGINIA: Beech Fork St. Pk, Wayne Co. (*tomentosa*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. spiniglobus* examined.—ARKANSAS: Palestine, IX-10-2004 (larva). CONNECTICUT: Danbury, IX-6-2005 (larva). MARYLAND: Ridgely, IX-23-1999 (larvae) & IX-2-2000 (♂, ♀, em. IV-2001). TENNESSEE: Dickson, IX-11-2004 (larvae).

Caryomyia spinulosa Gagné, new species

Description.—Gall (Figs. 92–93): Occasional, known from bitternut of the *Apocarya* section; found singly or in small groups, attached to leaf vein, usually on lower leaf surface, occasionally on upper leaf surface; 6.2–8.0 mm in length, recumbent, base bulbous, tapered beyond into elongate, usually abaxially bowed extension with pointed apex; green, yellow, to tan, covered with short, white, downy, crinkled hairs not obscuring surface; base of gall with central conical pedicel in shallow circular indentation; wall firm, brittle, uniformly thin, larval chamber glabrous with longitudinal ridges following gall axis from leaf vein connection to apex. This gall is superficially similar to those of *C. procumbens* and *C. supina*. It is known only from bitternut, while those of the other two occur on the *Eucarya* group, except for one known exception in *C. supina*. The gall of *C. spinulosa* has hair, as does that of *C. procumbens*, but the hair on the gall of *C. spinulosa* is downy and crinkly rather than stiff and straight and the gall base is much more bulbous. The gall of *C. supina* is hairless and not bulbous basally.

Adult: Unknown.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 1.7–2.1 (8). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 295) with single tooth narrowing slightly from base to apex, shallowly notched apically, shaft anteriorly, narrowed beyond to widen again posteriorly. Papillae without setae, their bases not raised. Lateral papillae 2–3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdomen with extensive verrucae on dorsum, particularly at midlength, and with horizontal rows of spicules on venter anterior to sternal papillae and on posterior third. Terminal segment shorter than eighth. Second instar: Length 0.9 (1). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not appreciably raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—Holotype: Third instar, from gall on *C. cordiformis*, Pavia, Pennsylvania, IX-3-2003, R.J. Gagné, deposited in USNM.

Etymology.—The name *spinulosa* is a Latin adjective and refers to the spinelike shape of the gall.

Affinities.—*Caryomyia spinulosa* is one of the three *Caryomyia* spp. restricted to bitternut. This species and the other two, *C. cilidolum* and *C. ansericollum*, each appear most closely related to species found on the *Eucarya* group and not to one another. For further discussion of *C. spinulosa*, see under *C. eumaris*.

Collections (all from *Carya cordiformis*).—ARKANSAS: Harrison; London. INDIANA: Plainville. MARYLAND: Ellicott City. MASSACHUSETTS: Barre. MISSOURI: Oregon Co., junc. Rts 11 & 142. PENNSYLVANIA: Pavia. NEW YORK: Ithaca. VIRGINIA: Rt. 81, mi. 13.9, Washington Co. WEST VIRGINIA: Falling Waters.

Specimens of *C. spinulosa* examined.—ARKANSAS: London, IX-10-2004 (larva). INDIANA: Plainville, IX-7-2004 (larva). MARYLAND: Ellicott City, IX-2-2000 (larvae). MASSACHUSETTS: Barre, IX-1910, C.H. Clarke (larva). PENNSYLVANIA: Pavia,

IX-3-2003 (larva). **NEW YORK:** Ithaca, IX-3-2003 (larvae). **WEST VIRGINIA:** Falling Waters, IX-10-2005 (larva), X-2005 (larva; pupa, excised from gall IV-28-2006).

Caryomyia stellata Gagné, new species

Description.—*Gall* (Figs. 11a, 143): Occasional, on *Eucarya* hickories; single or clustered, on lower leaf surface between veins; 5.0–9.0 mm in height, elongate-conical, base flared laterally, the flattened edge often stellate, sometimes merely irregularly lobed, cone usually greatly attenuate and slightly curved to apex, furrowed; surface smooth, bare, green turning purple; base with shallow, circular, central excavation, leaf with no exfoliation surrounding connection; larval chamber ovoid, located at base of gall, surrounded by yellowish pellicle different in texture from soft, viscous, usually purple surrounding tissue that collapses with age, a bundle of fibers traversing between larval chamber and gall apex. Galls from Florida, Georgia, and Maryland are only tentatively placed with this species. They are the only ones found east of the Appalachians and are only shallowly lobed at the base and the lobes are rounded. West of the Appalachians the galls are more common, the bases more stellate, and the cones much longer (Fig. 143). Galls of this species have the same basic shape as those of *C. sanguinolenta* except for a much higher crown and flared sides.

Adult and pupa: Unknown.

Larva: **Third instar:** Length 1.8–2.6 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 296) with long, nearly parallel sided, apically notched tooth and long shaft. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded verrucae covering dorsum at mid-length and horizontal rows of spicules on venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Length 0.8 mm (n=1). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype:* Third instar, from gall on *C. tomentosa*, Jackson, Tennessee, IX-11-2004, R.J. Gagné, deposited in USNM.

Etymology.—The name *stellata*, a Latin adjective, refers to the stellate base of the typical form of the gall.

Affinities.—See under *C. sanguinolenta*, from which this species differs in the shape of the gall.

Collections of galls.—**ALABAMA:** Oak Mt. St. Pk, Shelby Co. (*ovata*, *pallida*). **ARKANSAS:** Beulah (*ovata*); Magazine Mt., Logan Co. (*ovata*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Litchfield (*ovata*); Plainfield (*ovata*); Westchester (*ovata*). **FLORIDA:** Avon Park (*floridana*); Gainesville (*glabra*, *tomentosa*). **GEORGIA:** Lake Park (*glabra*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Grayson Lake St. Pk, Carter Co. (*tomentosa*); Pennyrite St. Pk, Christian Co. (*ovata*); Winchester (*laciniosa*). **MAINE:** North Berwick (*ovata*). **MARYLAND:** Gaithersburg (*tomentosa*); Silver Spring (*glabra*). **MASSACHUSETTS:** Great Barrington (*ovata*); Boston (*tomentosa*); Leominster (*ovata*); Petersham (*ovata*); Springfield (*Carya* sp., Stebbins 1910: Fig. 13). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 123, Rankin Co. (*pallida*, *tomentosa*); Noxubee Natl Wildlife Ref., Oktibbeha Co. (*ovata*); nr. Sessums, Oktibbeha Co. (*ovata*); 7 mi E Starkville (*pallida*). **MISSOURI:** Wildwood (*tomentosa*). **NEW HAMPSHIRE:** Barrington (*ovata*); Exeter (*ovata*); Seabrook (*ovata*). **NEW YORK:** Albany (*Carya* sp.); E. Schodack (*Carya* sp.). **OHIO:** Hocking Co. (*ovata*, Wells 1916: Figs. 11a); Huron Co. (*Carya* sp., Sears 1914: Fig. 14). (*tomentosa*); Yellow Springs (*glabra*). **OKLAHOMA:** Sallisaw (*tomentosa*). **TENNESSEE:** Jackson (*tomentosa*). **WEST VIRGINIA:** 6 mi NW Hedgesville (*ovata*).

Specimens of *C. stellata* examined.—**ARKANSAS:** Beulah, IX-10-2004 (larvae). **FLORIDA:** Gainesville, IX-21-2000 (larvae). **INDIANA:** Spencer Co., IX-20-1995 (larvae). **KENTUCKY:** Winchester, IX-22-1995 (larvae). **MASSACHUSETTS:** Leominster, IX-21-1994 (larvae). **NEW HAMPSHIRE:** Exeter, IX-21-1994 (larvae). **OKLAHOMA:** Sallisaw, IX-9-2004 (larvae). **TENNESSEE:** Jackson, IX-11-2004 (larvae). **WEST VIRGINIA:** 6 mi NW Hedgesville, VIII-16-2000 (larvae).

Caryomyia striolacrustum Gagné, new species

Description.—*Gall* (Figs. 31, 84–85): Common, on *Eucarya* hickories; on lower leaf surface between veins, usually clustered; height 2–3 mm, usually about as wide as long, basal half conical

and deeply set into leaf swelling detectable on top surface of leaf as tan to black, conspicuous convexity, apical half of gall short-cylindrical with funnel-like, deep, narrow to wide concavity surrounded by correspondingly narrow to thick walls, center of funnel with short umbo; surface not sticky, yellow to brown, minutely longitudinally striated, the striations partly fibrous on distal half; gall often surrounded and occasionally partially covered by conspicuous, brown, irregularly shaped leaf exfoliation; larval chamber in basal half of gall, wall firm, thin basally, thicker distally than laterally, glabrous, with longitudinal ridges. The shape of the gall most closely resembles that of *C. melicrustum* but the surface of the latter is mucilaginous and smooth.

Adult: **Head:** Antenna with 12 flagellomeres. Male flagellomeres (as in Fig. 237) scarcely bimodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella (as in Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. **Thorax:** Wing length 1.4 mm in male (n=1); 2.1 mm in female (n=1). **Male abdomen:** Third through seventh tergites each with posterior setae in single; sparse row continuous across width; eighth tergite without posterior setae. Genitalia (as in Figs. 247–248): hypoproct broadest near apex, concave posteromedially, margin setose, dorsal surface devoid of setulae on anterior 2/3; apex and venter of aedeagus furrowed. **Female abdomen:** Third through seventh tergites each with posterior setae continuous across width, in single row; eighth tergite with no posterior setae. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.3–2.7 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 288) with pointed, almost equilateral anterior tooth, occasionally with slight notch at

apex, and anteriorly widened, elongate shaft. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with no verrucae on dorsum or sparse verrucae near bases of lateral pairs of dorsal papillae and with spicules on venter anterior to sternal papillae. Terminal segment shorter than eighth. **Second instar:** Length 0.7–0.9 mm (n=4). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. glabra*, National Arboretum, Washington, DC, IX-22-1988, R.J. Gagné, deposited in USNM.

Etymology.—The name *striolacrustum*, a noun, is formed from the Latin *striolatus* for finely lined and crustum for tart, with reference to the striations covering the tart-like gall.

Affinities.—Galls of this species, short with a conical base set into an encircling leaf socket, are most like those of *C. melicrustum* except that they are finely striate and not resinous. For further remarks, see under *C. flaticrustum*.

Biological notes.—This gall appears to burst out of the leaf after it is mostly formed. In mid-June in central Maryland new galls could be found in various stages of emergence from the leaf epidermis. These contained first instars. By mid-July to mid-August, fully emerged galls contained second instars or third instars.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*ovata, tomentosa*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata, pallida*). **ARKANSAS:** 3 mi S Harrison (*tomentosa*); Magazine Mt., Logan Co. (*ovata, texana, tomentosa*); 2 mi S DeQueen (*texana, tomentosa*); Rt.1 at Red River, Little River Co. (*tomentosa*). **CONNECTICUT:** Amston (*ovata*); Meriden (*glabra, ovata*); New Haven (*glabra*); Phoenixville (*ovata*); Southbury (*glabra, tomentosa*); Westchester (*ovata*). **FLORIDA:** St. Lucie (*floridiana*); Sebring (*floridiana*); Vero Beach (*floridiana*). **GEORGIA:** Carnesville (*glabra*); 8 km E Fort Valley (*pallida*); Forsyth (*glabra, ovata*); Lizella (*ovata, tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson Lake St. Pk, Carter Co. (*tomentosa*); Morehead (*tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Pennyrike St. Pk, Christian Co. (*glabra*,

ovata); Winchester (*lacinosa*). **MAINE:** North Berwick (*ovata*). **MARYLAND:** Beaver Dam (*tomentosa*); Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Clarksburg (*tomentosa*); Ellington City (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*glabra, tomentosa*); Potomac (*tomentosa*); Ridgely (*tomentosa*); Silver Spring (*glabra, tomentosa*); Snow Hill (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra, tomentosa*). **MASSACHUSETTS:** Great Barrington (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); Wrentham (*ovata*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 193, Choctaw Co. (*glabra, pallida, tomentosa*); Noxubee Natl Wildlife Ref., Oktibbeha Co. (*ovata, tomentosa*); nr. Sessums, Oktibbeha Co. (*ovata*); 7 mi E Starkville (*pallida*). **MISSOURI:** Crowley Ridge Roadside Pk, Stoddard Co. (*glabra, tomentosa*); Holly Ridge State For., Stoddard Co. (*glabra, tomentosa*). **NEW HAMPSHIRE:** Barrington (*ovata*); Dover (*ovata*); Kingston (*ovata*). **NEW JERSEY:** Columbia (*ovata*); Nyack (*tomentosa*); Columbia (*tomentosa*). **NEW YORK:** Saratoga Springs (*ovata*). **NORTH CAROLINA:** Alamance (*tomentosa*); Alberta (*glabra*); Dorchest (*glabra, tomentosa*); Fayetteville (*tomentosa*); Gastonia (*tomentosa*); Providence (*glabra, tomentosa*); Rowland (*tomentosa*); Wise (*tomentosa*). **OHIO:** Hocking St. For., Hocking Co. (*tomentosa*); Hocking Co. (*Carya* sp., Wells 1916: Fig. 31). **OKLAHOMA:** Sallisaw (*tomentosa*). **SOUTH CAROLINA:** Dillon (*tomentosa*); Richland Co. **TENNESSEE:** Gatlinburg (*glabra, tomentosa*); Greene Co., I 81, Mile 38.5 (*ovata, tomentosa*). **TEXAS:** Daingerfield St. Pk, Morris Co. (*tomentosa*). **VIRGINIA:** Blue Ridge Pkwy Mile 4.6, Warren Co. (*ovata*); Carson (*tomentosa*); Dinwiddie (*glabra, tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); Rt. 81, mi. 13.9, Washington Co. (*ovata*). **WASHINGTON, DC:** National Arboretum (*glabra, tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); Cooper's Rock St. Pk, Preston Co. (*glabra*); 6 mi. NW Hedgesville (*tomentosa*).

Specimens of *C. striolacrustum* examined.—**ALABAMA:** Greenville, IX-20–2000 (larvae). **CONNECTICUT:** Phoenixville, IX-20–1994 (larvae). **FLORIDA:** St. Lucie, XI-7 to 12–2002, K. Hibbard (larvae); Sebring, XI-13–2002 (larvae); Vero Beach, IX-12–2002 (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, X-8–2002 (larvae; ♂, ♀, pupae, em IV-2003); Lusby, IX-16–2003 (larvae). **NORTH CAROLINA:** Wise, IX-18–2000 (larvae).

OKLAHOMA: Sallisaw, IX-9–2004 (larva). **WASHINGTON, DC:** National Arboretum, IX-22–1988 (larva).

Caryomyia striolata Gagné, new species

Description.—**Gall** (Figs. 36–38): Common, a spring gall, on both *Eucarya* and *Apocarya* hickories; found singly or in groups on lower, rarely on upper, leaf surface, between or adjacent to veins; 3.5–5.0 mm in height, usually upright, sometimes leaning, base truncate, cylindrical, more or less fluted, tapering gradually to pointed apex; with sparse resin glands sometimes simulating hairs especially on young galls, white to green, occasionally with some red, turning brown; base of gall shallowly concave; wall uniformly thin, larval chamber rough with weak, longitudinal ridges. This gall is similar in shape to that of *C. albipilosa*, but lacks a thick covering of long white hair.

Adult (male only): Head: Antenna with 12 flagellomeres; each of the regular 12 male flagellomeres (as in Fig. 235) scarcely binodal, basal flagellomeres only slightly narrowed beyond basal circumfilum, less constricted on more distal flagellomeres, loops of circumfila short, subequal in length. **Thorax:** Wing length 1.7 mm (n=1). **Male abdomen:** Third through sixth tergites each with posterior setae continuous across width, in mostly single row; seventh tergite with only a few posterolateral setae; eighth tergite more weakly sclerotized, with anterior pair of trichoid sensilla the only vestiture. Genitalia (as in Figs. 249–250): hypoproct broadest posteriorly, weakly concave posteromedially, posterior margin setose, dorsal surface extensively setulose; aedeagus narrowing from base to apex, rounded at apex.

Pupa (as for Figs. 267–268): Antennal bases parallel in ventral view, carinate anteroventrally, the mesal corner elongated, terminating anteriorly in short, obtuse projection. Face without incisions, frons and clypeus not protruding. Abdominal tergal spinules all similarly small.

Larva: **Third instar** (Figs. 215–217, 269–271): Length 1.2–2.0 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 274) with 2 separate, equilateral teeth anteriorly, the intervening space with 1–4 denticles. Two, occasionally 3, lateral papillae each side of spatula. Six dorsal papillae on first 7 abdominal segments. Papillae without setae, bases not raised. Abdominal segments

laterally with pointed spicules, dorsally lined, subverrucose, with sparse, pointed spicules mainly surrounding the 2 lateral pairs of dorsal papillae, and ventrally covered with spicules anterior to ventral papillae. Terminal segment as long as eighth. **Second instar:** Length 0.7–1.1 mm (n=10). Collar segment without enlarged spicules laterally. Without spatula. Bases of dorsal and pleural papillae slightly raised, asetose. Six dorsal papillae on first 7 abdominal segments. **First instar** (Fig. 35): Ovoid. Spicules present anteroventrally on abdominal segments.

Type material.—*Holotype*: Third instar (second specimen from right of four specimens on slide), from gall on *C. tomentosa*, Entomology Road, BARC-East, Beltsville, Maryland, V-16–2000, R.J. Gagné.

Etymology.—The name *striolata* is a Latin adjective meaning furrowed or fluted and refers to the gall's texture.

Affinities.—This species can be separated from *C. albipilosa* only by the lack of hair on the gall of this species and the thick coat of hair on the galls of *C. albipilosa*. See under the latter species for further discussion.

Biological notes.—Galls of this species and *C. albipilosa* are the earliest *Caryomyia* galls to appear in spring and grow to full size within a few days. Young galls are at first mostly green and soon develop some red tinge. While the host leaves were still flaccid in early May, galls were found already fully formed, all with similar mature shape and size, with each containing a first, second, or third instar. In other years, galls found on May 16–19 contained second and third instars and by May 23 most galls were hanging loosely on the leaves or had already dehisced as indicated by abscission scars. On May 28, galls remaining on the leaves contained dead or parasitized larvae. These galls eventually turned brown and did not dehisce because the gall ceased development upon the death of the larva and never completed an abscission layer. Any galls found on leaves after June 5 were brown and contained only dead or parasitized larvae. Such galls could be found through September.

Collections of galls.—**ALABAMA:** Auburn (*aquatica*). **CONNECTICUT:** Meriden (*tomentosa*); Plainfield (*ovata*); Southbury (*tomentosa*). **GEORGIA:** Forsyth (*glabra*, *ovata*). **KENTUCKY:** Cave Run Lake, nr. Morehead. (*Carya* sp.). **MARYLAND:** Beltsville,

USDA Agricultural Research Center (*glabra*, *tomentosa*); Calverton (*glabra*, *tomentosa*); Ellicott City (*cordiformis*, *tomentosa*); Kemp Mill (*glabra*); Myersville (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*cordiformis*, *tomentosa*). **NEW JERSEY:** Columbia (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra*, *tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** Falling Waters (*cordiformis*); Hedgesville (*ovata*).

Specimens of *C. striolata* examined.—**CONNECTICUT:** Meriden, VI-4–1994 (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, V-22–1993, V-26 & VI-4–1997, V-14–1998, V-4 & 16–2000, & V-4–2004 (larvae); Calverton, V-4–2004 & V-15–2005 (larvae); Ellicott City, VI-8–2005 (larvae); Wheaton, V-30–1994 (larvae; ♂, pupa, em. IV-1995) & V-19–2000 (larvae).

Caryomyia subulata Gagné, new species

Description.—*Gall* (Figs. 27, 72–73): Occasional, on *Eucarya* hickories but not east of Appalachian Mts; usually in scattered groups, on lower leaf surface between veins; length 6.0–9.0 mm, elongate-cylindrical, erect, slightly bowed, tapered to pointed apex; shiny, brown, becoming black; base of gall deeply recessed, and set into socket formed from thick, scabrous, leaf growth with sharp apical edge; larval chamber occupying full length of gall, green, longitudinally striated, the wall firm, brittle, uniformly thin. This gall superficially resembles that of *C. tubicola* but the apex of the present gall is tapered rather than blunt and its base is deeply recessed rather than conical.

Adult and pupa: Unknown.

Larva: **Third instar:** Length 1.8–2.2 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 285) with 2 widely separated anterior teeth, the space between concave, shaft long, widest anteriorly. Papillae without setae, their bases not raised. Lateral papillae 2–3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments completely covered on dorsum with verrucae and on venter with spicules except at midlength around sternal papillae. Terminal segment as long as eighth. **Second instar:** Length 0.9–1.1 mm (n=3). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and

longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae raised, papillae asetose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar (specimen farthest to right of three on slide), from gall on *C. tomentosa*, 6 mi W Hedgesville, Morgan Co., West Virginia, IX-19-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *subulata* is a Latin adjective meaning awl-shaped with reference to the elongate-conical, tapered gall.

Affinities.—The closest relative of this species is not apparent. The spatula with its two widely separated teeth but long, narrow shaft is unique for the genus. The elongate gall set into a deep socket only superficially resembles that of *C. tubicola* (Figs. 75–77). Notable differences are that the gall of *C. subulata* is spinelike, completely hollow within, and has a deeply excavated base, whereas the gall of *C. tubicola* is evenly cylindrical, has some woody tissue within, and has a conical base.

Collections of galls.—ARKANSAS: Piney (*texana*). CONNECTICUT: Amston (*ovata*); Danbury (*ovata*); Hartland (*ovata*); Litchfield (*ovata*); Meriden (*ovata*). ILLINOIS: Marshall (*tomentosa*). INDIANA: Spencer Co. (*ovata*). KENTUCKY: Grayson Lake St. Pk, Carter Co. (*tomentosa*); Winchester (*laciniosa*). MAINE: North Berwick (*ovata*). MASSACHUSETTS: Petersham (*ovata*). MISSISSIPPI: nr. Sessums (*ovata*). NEW HAMPSHIRE: Exeter (*ovata*). NEW JERSEY: Columbia (*ovata*). NEW YORK: Herkimer (*ovata*). OHIO: Hocking Co. (*ovata*, Wells 1916: Fig. 27); St. Clairsville (*tomentosa*); Summerford (*tomentosa*). ONTARIO: Dundas (*ovata*). PENNSYLVANIA: Kirby (*ovata*). TENNESSEE: Greene Co., I 81, Mile 38.5 (*tomentosa*). WEST VIRGINIA: Beech Fork St. Pk, Wayne Co. (*ovata*); 6 mi NW Hedgesville (*ovata, tomentosa*).

Specimens of *C. subulata* examined.—CONNECTICUT: Amston, IX-19-1994 (larva); Hartland, IX-7-2006 (larvae). INDIANA: Spencer Co., IX-20-1995 (larvae). KENTUCKY: Winchester, IX-22-1995 (larvae). MAINE: North Berwick, IX-21-1994 (larva). OHIO: St. Clairsville, IX-6-2004 (larvae). ONTARIO: Dundas, VIII-17-1994 (larvae). WEST VIRGINIA: 6 mi. NW Hedgesville, VIII-20-1997, IX-19-1999, & VII-4-2000 (larvae).

Caryomyia supina Gagné, new species

Description.—*Gall* (Figs. 96-97): Occasional on *Eucarya* hickories and found once on bitternut of *Apocarya* section, occurs singly or in small groups;

attached to side of vein on lower leaf surface; 6.0–8.0 mm in length, recumbent, base lobed across attachment to vein but not bulbous, gradually narrowing along length to pointed apex; green, yellow, to tan, hairless; base of gall with central conical pedicel in shallow, circular indentation; wall firm, brittle, uniformly thin, larval chamber glabrous with longitudinal ridges following gall axis from leaf vein connection to apex. See remarks about similar galls under *C. spinulosa*.

Adult and pupa: Unknown.

Larva: Third instar: Length 1.3–2.2 mm (n=7). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 292) with single tooth almost parallel-sided, deeply notched anteriorly, the tines slightly splayed, shaft wide anteriorly, narrowed beyond. Papillae without setae, their bases not raised. Lateral papillae 2–3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdomen with extensive verrucae on dorsum, particularly at midlength, and with horizontal rows of spicules on venter anterior to sternal papillae and covering posterior third. Terminal segment shorter than eighth. **Second instar:** Length 0.8–1.2 mm (n=5). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not appreciably raised, papillae asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. glabra*, Wheaton, Maryland, IX-19-1993, R.J. Gagné, deposited in USNM.

Etymology.—The name *supina* is a Latin adjective that refers to the supine habit of the gall.

Affinities.—See under *C. eumaris*.

Collections of galls:—ALABAMA: Auburn (*glabra, ovata, tomentosa*). ARKANSAS: Piney (*texana*). CONNECTICUT: New Haven (*glabra*); Phoenixville (*ovata*); Southbury (*glabra*); Westchester (*ovata*). GEORGIA: Forsyth (*ovata*). KENTUCKY: Pennyriile St. Pk, Christian Co. (*ovata*). MARYLAND: Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Brighton (*tomentosa*); Clarksburg (*tomentosa*); Kemp Mill (*glabra*); Gaithersburg (*glabra, tomentosa*); Silver Spring (*glabra*); Spencerville (*tomentosa*); Wheaton (*cordiformis, glabra*). MASSACHUSETTS: Bolton (*ovata*). MISSOURI: Mark Twain Natl For., Ripley Co. (*tomentosa*).

Specimens of *C. supina* examined.—ARKANSAS: Piney, IX-10-2004 (larva). CONNECTICUT: New

Haven, IX-19-1994 (larvae). MARYLAND: Beltsville, USDA Agricultural Research Center, IX-11-1994, VI-15-2000 & VII-1-2000 (larvae); Silver Spring, IX-26-1988 & IX-6-2003 (larvae); Spencerville, IX-21-2003 (larvae); Wheaton, IX-19-1993 (larvae).

Caryomyia thompsoni (Felt)

Hormomyia thompsoni Felt 1908: 388; Felt 1918d: 47 (*Caryomyia*).

Caryomyia consobrina Felt 1909: 292. New synonym.

Caryomyia similis Felt 1909: 292. New synonym.

Description.—*Gall* (Figs. 23, 112–115): One of the commonest *Caryomyia* galls, on *Eucarya* hickories; usually in clusters, on lower leaf surface between veins; 1.5–2.6 mm in height, depressed-spheroidal, often distended to one side, with deep dimple at center top; hair whitish gray, either sparse and not obscuring green to brown shiny surface or dense and obscuring gall surface; base of gall at center with deep, central, circular, shallow depression, the leaf without exfoliation surrounding connection; wall of uniform thickness, firm, woody, the larval chamber invaded from both apex and base by vertical cylindrical intrusions, the apical intrusion bearing crinkly hairs, both intrusions nearly abutting one another at center of larval chamber. Galls of this species vary considerably in hairiness, ranging from sparsely haired (Fig. 113) to so hairy as to obscure the gall surface (Fig. 115). Sparsely and densely haired examples are commonly found intermixed and closely adjacent on a leaf (Fig. 112). The gall is unique for the vertical column through the center of the larval chamber made of the combined apical and basal intrusions of the gall wall. The only other *Caryomyia* gall with any intrusion is that of *C. holotricha*, but the intrusion in the latter is only of hair growing inward from the apex of the gall.

Adult: **Head:** Antenna with 12 flagellomeres, in male a short, thirteenth flagellomere present in some specimens, but without circumfila; each of regular male flagellomeres (as in Fig. 239) binodal, internodes and necks both shorter than basal node; loops of circumfila short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella (as in Fig. 242) partially fused, blunt apically, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 3.5–4.2 mm in male (n=5); 3.0–3.5 mm in female (n=5). **Male abdomen:**

Third through eighth tergites each with posterior setae in mostly double row, narrowing to single row mesally, sometimes discontinuous in middle. Genitalia (Figs. 252–253) cerci short, broadly rounded apically, setose dorsally and posteriorly; hypoproct broadest near apex, concave posteromesally, margin setose, setulose only posteriorly on dorsum, completely ventrally; aedeagus broad, apex rounded, not furrowed; gonocoxite short, broad; gonostylus broad, with scattered setae, covered with setulae, the tooth nearly as wide as gonostylus. **Female abdomen:** Third through eighth segments with 2–3 rows of setae, tapering to 1 row and slightly discontinuous mesally. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.6–2.8 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 316) with simple, apically-pointed tooth, the shaft long, widest anteriorly and posteriorly, tapering from both ends to narrow midlength. Papillae without setae, their bases not raised above level of verrucae. Lateral papillae usually 3, occasionally 2 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Body completely covered by verrucae. Terminal segment shorter than eighth. **Second instar:** Length 1.0–1.4 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae raised but asetose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Hormomyia thompsoni* Felt: Lectotype here designated, photograph of gall in Thompson (1915: 90, Fig. 227) from *Carya* sp., locality unspecified, presumably vicinity of Worcester, Massachusetts, M.T. Thompson. Paralectotype ♂, 1116a, Thompson 227, ex *Carya* sp., locality unspecified, presumably Worcester, Massachusetts, M.T. Thompson, in Felt Collection, New York

State Museum. The photo in Thompson (1915) is of the sparse-haired form of the gall. I choose to make the gall photo (actual specimen not seen) the lectotype because the species it belongs to is definite, whereas the single male described by Felt (now the paralectotype) cannot have come from this gall and cannot otherwise be placed with confidence. Antennal flagellomeres of this male are of the more foreshortened type found elsewhere in the genus and the aedeagus is furrowed. Felt's (1918, 1921) subsequent figures and descriptions of *C. thompsoni* also were not of this species. In both papers Felt showed a photo of galls from New York City of specimens still in the Felt Collection and labelled with his unique number "a1908." These galls are a mixture of *C. holotricha* and *C. purpurea* galls. Felt (1921) described the larva and adults of purported *C. thompsoni* with the note number "a1908." The larva he described belongs to *C. purpurea*. The accompanying adults in the numbered series are not *C. purpurea* and fit neither the paralectotype of *C. thompsoni* or adults that I have reared from galls similar to the lectotype.

Caryomyia consobrina Felt: *Lectotype*, here designated, ♂, a1948, collected IX-8-1908, reared IV to V-1909 from depressed globular gall of *Carya* sp., Nassau, NY, deposited in the Felt Collection, New York State Museum. *Paralectotypes*, ♂, ♀, pupa, and larva, all with the same data as the lectotype. Galls typical of the dense-haired form of *C. thompsoni* and labelled "a1948" are also in the Felt Collection.

Caryomyia similis Felt: *Lectotype*, here designated, larva, a1946, collected IX-16-1908 from gall of *Carya* sp., Nassau, NY, Felt Collection, New York State Museum. *Paralectotypes*: 3 ♂, 5 ♀, same pertinent data as lectotype, but belonging to *C. antennata* on the basis of abdominal vestiture and the shape of the male flagellomeres. Two paralectotype series of galls in the Felt collection, both labelled "a1946" and "*C. similis*," are of two kinds, one of the dense-haired form of *C. thompsoni*, from which the lectotype was apparently taken, the other of *C. antennata*, presumably the source of the paralectotype adults.

Etymology of names in this taxon.—Felt named *C. thompsoni* in honor of Millett Taylor Thompson, a professor at Clark University in Worcester, Massachusetts, who had by the time of his death at 32 in 1907 partially prepared an illustrated catalog on the gall makers of North Amer-

ica. His book (Thompson 1915), edited by Felt, was posthumously published in accordance with the provisions of Thompson's father's will. The name *consobrina* is Latin meaning cousin; Felt (1921) remarked that he found a general resemblance between galls of this species and that of *C. antennata*. The name *similis* is a Latin adjective meaning similar; as Felt (1921) explained, he thought that the galls were easily mistaken for those of *C. caryae*.

Affinities.—In adult, pupal, and larval characters this species is similar to *C. holotricha*. The two species are the only congeners with an apical intrusion of hairs into the larval chamber. The galls are otherwise distinct in that those of the present species have an additional intrusion into the base of the larval chamber and the apex of the gall is dimpled, not conical.

Biological notes.—In central Maryland, very tiny to full-size galls were found on the same leaflet as early as May 23. Young galls were greenish white turning light yellow with bright white hair. The larvae were all first instars. By June 9, galls appeared full-size and brittle but the larvae were still all first instars. In mid-June through mid-July galls were mostly hard, brittle, and brown to black and contained second instars, but during this time soft galls could still be found with first instars. By the beginning of August galls contained second or third instars and by mid-August more than half the larvae were third instars. Adults emerged in late March and early April from galls collected in New York, New Hampshire, Maryland, and Texas.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*glabra*, *pallida*, *ovata*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*pallida*). **ARKANSAS:** Beulah (*tomentosa*); Chester (*texana*); Magazine Mt., Logan Co. (*ovata*); Palestine (*ovata*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Hartland (*ovata*); Harwinton (*ovata*); Litchfield (*ovata*); Meriden (*glabra*, *ovata*); New Haven (*glabra*); Oakille (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Southbury (*glabra*); Southington (*ovata*); Thomaston (*ovata*); Westchester (*ovata*). **FLORIDA:** Avon Park (*floridana*); Gainesville (*glabra*, *tomentosa*). **GEORGIA:** Carnesville (*glabra*); Forsyth (*glabra*); 8 km E Fort Valley (*pallida*); Lizella (*ovata*); Macon (*glabra*). **ILLINOIS:** Highland (*laciniosa*). **KENTUCKY:** Brownsville (*tomentosa*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*texana*). **MAINE:** Eliot (*tomentosa*). **MARYLAND:** Beaver Dam

(*tomentosa*); Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Calverton (*tomentosa*); Clarksburg (*tomentosa*); College Park (*glabra*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*glabra, tomentosa*); Piney Grove (*ovata*); Potomac (*tomentosa*); Ridgely (*glabra*); Snow Hill (*tomentosa*); Spencerville (*tomentosa*); Silver Spring (*glabra, tomentosa*); Wheaton (*glabra, tomentosa*). MASSACHUSETTS: Holyoke (*ovata*); Merrimac (*ovata*); vic. Worcester (*Carya* sp., Thompson 1915: 91, Fig. 227); Wrentham (*ovata*). MISSISSIPPI: Noxubee Natl Wildlife Ref., Oktibbeha Co. (*ovata*); nr. Sessums, Oktibbeha Co. (*ovata*). MISSOURI: Crowley Ridge Roadside Pk, Stoddard Co. (*glabra, tomentosa*); Holly Ridge State For., Stoddard Co. (*glabra, tomentosa*); Rolla (*texana*); St. Clair (*tomentosa*); Wildwood (*tomentosa*). NEW HAMPSHIRE: Dover (*ovata*); Kingston (*ovata*). NEW JERSEY: Columbia (*ovata, tomentosa*). NEW YORK: Herkimer (*ovata*); Hyde Park (*ovata*); Ithaca (*ovata*); Nassau (*Carya* sp.); Ravana (*ovata*); Shokan (*glabra, tomentosa*). NORTH CAROLINA: Dorchies (*glabra, tomentosa*); Providence (*glabra, tomentosa*); Wise (*tomentosa*). OHIO: Hocking St. For., Hocking Co. (*ovata*); Hocking & Lake Cos. (*ovata*, Wells 1916: Fig. 23); St. Clairsville (*tomentosa*). OKLAHOMA: Sallisaw (*tomentosa*). ONTARIO: Dundas (*ovata*). PENNSYLVANIA: Mooresville (*tomentosa*); Pavia (*ovata*); Schellsburg (*glabra*). SOUTH CAROLINA: Dillon (*tomentosa*); Georgetown (*tomentosa*). TENNESSEE: Crossville (*pallida*); Dandridge (*tomentosa*); Dickson (*tomentosa*); Greene Co., I 81, mi 38.5 (*ovata*); Lebanon (*glabra*); Mohawk (*tomentosa*). VIRGINIA: Dinwiddie (*glabra, tomentosa*); Warren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Rt. 81, mi. 13.9, Washington Co. (*ovata*). WASHINGTON, DC: Rock Creek Park (*ovata*); National Arboretum (*glabra*); Walter Reed Army Medical Center (*tomentosa*). WEST VIRGINIA: Beech Fork St. Pk, Wayne Co. (*tomentosa*); Capon (*ovata*); Cooper's Rock St. Pk, Preston Co. (*glabra, ovata*); 6 mi NW Hedgesville (*glabra, ovata, tomentosa*).

Specimens of *C. thompsoni* examined.—CONNECTICUT: Amston, IX-19-1994 (larvae); New Haven, IX-19-1994 (larvae); Phoenixville, IX-20-1994 (larvae). FLORIDA: Avon Park, IX-7 to 13-2002, K. Hibbard (larva); Gainesville, IX-21-2000 (larvae; 2 ♂, ♀, em. IV-2001). GEORGIA: 8 km E Fort Valley, IX-11-1993, J. & R. Payne (larvae); Lizella, X-12-1993, J. & R. Payne (larvae). KENTUCKY: Brownsville, IX-21-1995 (larvae). MARY-

LAND: Beltsville, USDA Agricultural Research Center, V-29-, VI-29-, and VII-1-1998 (larvae), IX-23-2005 (larvae; 7 ♂, 23 ♀, pupae, em. IV-7 to 20-2006); Gaithersburg, V-23-2000 (larvae); Silver Spring, X-24-1999 (larvae); Wheaton, IX-19-1993 (larvae). NEW HAMPSHIRE: Kingston, IX-21-1994 (larvae; ♂, 2 ♀, pupae, em. IV-1995). NEW YORK: Herkimer, IX-4-2003 (larvae; pupa, emerged IV-10-2004); Nassau, IX-16-1908, E.P. Felt (larvae, incl. lectotype of *C. similis*), IX-8-1908, E.P. Felt (♂, ♀, pupae, em. IV to V-1909, type series of *C. consobrina*). OHIO: Hocking St. For., Hocking Co., IX-19-1995 (larvae). ONTARIO: Dundas, VIII-17-1995 (larvae). TEXAS: New Waverly, X-6-2001 (♀, em. IV-2002). WASHINGTON, DC: National Arboretum, VI-11 & X-13-1997 (larvae), IX-30-1999 (larvae; 2 ♂, ♀, pupae, em. IV-2000). WEST VIRGINIA: 6 mi NW Hedgesville, IX-12 & 17-1999 (larvae).

Caryomyia tuberculata Gagné, new species

Description.—*Gall* (Figs. 118–119): Common, on *Eucarya hickories*; often in groups, on lower leaf surface between veins; 3.5–5.1 mm in height, depressed-spherical to spheroidal, occasionally with slightly pointed apex; surface hairless, bumpy, sticky, green, yellow, or brown to almost purple; base with large, central, deep, circular excavation, leaf without exfoliation surrounding connection; wall uniformly thick, woody, larval chamber ovoid, floccose, white, green, to purplish. The gall is most like that of *C. purpurea* because of its shape, the thick, woody wall, and the leaf connection but, unlike that of *C. purpurea*, is bumpy and hairless.

Adult: **Head:** Antenna with 12 flagellomeres, usually a short 13th flagellomere without circumfila present; each of regular 12 male flagellomeres (as in Fig. 239) binodal with definite internode and neck, the circumfila on each with short loops, their bases widely separated; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands, occasionally with an extra spur at base of vertical strand. Labella (as in Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 3.6–4.5 mm in male (n=5), 3.4–4.8 mm in female (n=5). **Male abdomen:** Third through eighth tergites each with posterior setae separated into two lateral groups, 2–3 rows deep laterally, narrowing to one mesally. Genitalia: hypoproct somewhat widened posteri-

orly, concave posteromesally, margin setose except in concavity, setulose on dorsum only on posterior fourth; apex of aedeagus convex. **Female abdomen:** Third through eighth tergites each with posterior setae separated into two lateral groups, 2–3 rows deep laterally, narrowing to one mesad; eighth tergite with posterior setae in 1–3 rows laterally and not as long or strong as on preceding tergite.

Pupa (as in Figs. 201–202): Antennal bases oblique in ventral view, converging and narrowing anteriorly, their rounded apices closely adjacent. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 1.9–3.5 mm (n=10). Body ovoid-cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 326) with tooth tapering from wide base to pointed apex and with elongate shaft. Papillae without setae, their bases not raised. Lateral papillae 3 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Abdominal segments on dorsum extensively covered with verrucae at midlength and on venter with horizontal rows of spicules anteriorly and posteriorly. Terminal segment shorter than eighth. **Second instar:** Length 1.7 mm (n=1). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, asetose. Six dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. tomentosa*, vic. Ridgely, Maryland, IX-23–1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *tuberculata* is an adjective from the Latin meaning bumpy and refers to the conspicuous bumps covering the gall surface of this species.

Affinities.—The closest relative among species with long male flagellomeres and an apically convex aedeagus is not apparent. Unlike other such species, such as *C. purpurea* and *C. holotricha* with spheroidal galls that occur on the leaf lamina and have a deep, circular, basal recess, *C. tuberculata* has pupal antennal bases that are closely juxtaposed apically instead of being distinctly separate.

Biological notes.—Tiny, yellow-green, soft galls containing first instars were first noticed in

central Maryland on June 10. On June 22 new and full grown galls were found on the same leaf, with first and second instars, respectively. Galls found from late June through mid-August contained second instars, after which third instars were regularly found. The full-grown larva fills the larval chamber. Adults emerge through a hole in the side of the gall.

Collections of galls.—**ALABAMA:** Auburn (*tomentosa*); Greenville (*tomentosa*). **ARKANSAS:** Chester (*texana*); Magazine Mt., Logan Co. (*tomentosa*); Piney (*texana*). **CONNECTICUT:** Amston (*ovata*); Meriden (*glabra*, *ovata*); New Haven (*glabra*); Oakville (*ovata*); Phoenixville (*ovata*); Plainfield (*ovata*); Southbury (*glabra*, *ovata*, *tomentosa*); Southington (*ovata*). **GEORGIA:** Forsyth (*ovata*); Lizella (*tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Grayson Lake St. Pk, Carter Co. (*tomentosa*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*tomentosa*). **MARYLAND:** Beaver Dam (*tomentosa*); Beltsville, USDA Agricultural Research Center (*glabra*, *tomentosa*); Brighton (*tomentosa*); Clarksburg (*tomentosa*); College Park (*glabra*); Gaithersburg (*tomentosa*); Lusby (*glabra*, *tomentosa*); Ridgely (*tomentosa*); Gaithersburg (*tomentosa*); Silver Spring (*tomentosa*); Snow Hill (*tomentosa*); Spencerville (*tomentosa*). **MASSACHUSETTS:** Leominster (*ovata*); vic. Worcester (*Carya* sp., Thompson 1915: 91, Fig. 244); Wrentham (*ovata*). **MISSISSIPPI:** Noxubee Natl Wildlife Ref., Okfobeha Co. (*ovata*). **MISSOURI:** Crowley Ridge Roadside Pk, Stoddard Co. (*glabra*); Holly Ridge State For., Stoddard Co. (*tomentosa*); St. Clair (*tomentosa*). **NEW HAMPSHIRE:** Kingston (*ovata*). **NORTH CAROLINA:** Alamance (*tomentosa*); Dorchies (*glabra*); Fayetteville (*tomentosa*); Providence (*tomentosa*). **OKLAHOMA:** Sallisaw (*tomentosa*). **PENNSYLVANIA:** Schellsburg (*ovata*). **SOUTH CAROLINA:** Dillon (*tomentosa*). **TENNESSEE:** Crossville (*pallida*, *tomentosa*); Dandridge (*tomentosa*); Mohawk (*tomentosa*). **VIRGINIA:** Carson (*tomentosa*); Dinwiddie (*glabra*, *tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra*, *tomentosa*); Walter Reed Army Medical Center (*tomentosa*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*); 6 mi NW Hedgesville (*tomentosa*).

Specimens of *C. tuberculata* examined.—**ARKANSAS:** Chester, IX-9–2004 (larvae); Piney, X-10–2004 (larvae). **CONNECTICUT:** Amston, IX-19–1994 (larva). **GEORGIA:** 8 km E Fort Valley, X-11–1993, J. & R. Payne (larvae). **NEW HAMPSHIRE:**

Kingston, IX-21-1994 (larvae; 5 ♂, 5 ♀, pupae, em. IV-1995). **MARYLAND:** Beltsville, USDA Agricultural Research Center, X-13-1999 (larvae; ♂, pupae, em. IV-2000) & IX-11-1994 (larvae); Gaithersburg, X-4-1994 (larvae); Lusby, IX-16-2003 (♀, pupa, em. IV-2004), IX-14-2005 (larvae; 7 ♀, pupae, em. IV-2 to 10-2006); Ridgely, IX-23-2000 (larvae); Silver Spring, IX-22-1993 (larvae). **MAS-**
SACHUSETTS: Wrentham, IX-20-1994 (larva). **WASH-**
INGTON, DC: National Arboretum, IX-22-1988 &
X-13-1997 (larvae), IX-30-1999 (larvae; ♂, ♀, em.
IV-2000); Walter Reed Army Medical Center, X-
7-1993 (♂, 5 ♀, pupae, em. IV-23 to 24-1994).
WEST VIRGINIA: 6 mi NW Hedgesville, IX-19-1999
(larvae).

Caryomyia tuberidolum Gagné, new species

Description.—**Gall** (Figs. 46–48): Common, on *Eucarya* hickories; often in groups, usually on lower, rarely on upper leaf surface, between veins; 3.2–4.0 mm in height, spheroidal, slightly longer than wide, base broadly rounded to truncate in profile, apex with small central nipple surrounded by extensive areola that with pressure easily separates from gall; surface covered with large bumps and resin glands, the sticky exudate in young galls sometimes extruded in hairlike strands, hairless, yellow, tan, or brown, areola paler than surrounding surface; base with wide, deep, circular indentation; wall firm, brittle, almost uniformly thin, larval chamber glabrous, with longitudinal ridges. For notes on galls of related species, see under *C. cilidolum*.

Adult (female only): Head: Antenna with 12 flagellomeres with anastomozing circumfila on venter (as in Fig. 241). Labella united, convex apically, setose, covered with setulae. **Thorax:** Wing length 3.1–3.3 mm in female (n=2). **Abdomen:** Third through seventh tergites each with posterior setae in 3 rows laterally, thinning to 2, then one, with slight medial interruption in setae; eighth tergite more weakly sclerotized than preceding tergite, with weak posterior setae numerous laterally, continuing mesally in single, sparse row. Ninth segment (as in Fig. 261) pliable except for slender dorsal sclerite, with numerous apico-lateral and ventral setae, none longer than the cerci, the two groups separated laterally. Cerci elongate-ovoid in lateral view, pointed apically, fused dorsally for about 1/2 length.

Pupa (Figs. 193–194): Antennal bases elongate, in ventral view parallel, closely adjacent, rounded

anteriorly, the apices dorsoventrally flattened. Face with longitudinal impression running along length, a slight anteromesal convexity posterior to each antennal base, and without anterolateral pair of horizontal incisions. Frons and clypeus slightly convex. Abdominal tergal spinules all similarly small.

Larva: Third instar: Length 2.6–4.8 mm (n=10). Body broadly rounded but knobby anteriorly, spindleform posteriorly. Head directed ventrally. Spatula (Fig. 280) with long, pointed anterior tooth and elongate shaft. Papillae prominently raised above surrounding surface, without setae. Lateral papillae numbering 2 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Body entirely covered with verrucae. Terminal segment as long as eighth, rounded posteriorly. **Second instar:** Length 1.0–1.5 mm (n=2). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Six dorsal papillae on first 7 abdominal segments. Bases of dorsal and pleural papillae elongate, asetose.

Type material.—**Holotype:** Third instar, from gall on *C. tomentosa*, Gaithersburg, Maryland, VII-20-2000, R.J. Gagné, deposited in USNM.

Etymology.—The name *tuberidolum*, a noun, combines the Latin words *tuberous* (bumpy) and *dolum* (jar), with reference to the bumpy, barrel-like gall.

Affinities.—See under *C. cilidolum*.

Biological notes.—In central Maryland, tiny to full-size galls were first noticed on May 24, the galls all with first instars. Second instars were present in some galls by June 25, but most galls still contained first instars through July 8. Third instars began appearing by mid-July and second instars could still be found through Aug. 19. Second and third instars are active when disturbed.

Collections of galls.—**ALABAMA:** Auburn (*glabra*, *ovata*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*pallida*). **ARKANSAS:** Beulah (*tomentosa*); Osage (*texana*); Winslow (*ovata*). **CONNECTI-**
CUT: Amston (*ovata*); Danbury (*ovata*); Litchfield (*ovata*); Meriden (*glabra*, *ovata*); Phoenixville (*ovata*); Southbury (*glabra*); Southington (*ovata*); Westchester (*ovata*). **GEORGIA:** Lake Park (*glabra*); Forsyth (*glabra*); 8 km E Fort Valley (*pallida*). **KEN-**
TUCKY: Brownsville (*tomentosa*); Grayson Lake St. Pk (*glabra*); Morehead (*tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*). **ILLINOIS:** Marshall (*tomentosa*). **MARYLAND:** Beltsville, USDA

Agricultural Research Center (*tomentosa*); Brighton (*tomentosa*); Calverton (*tomentosa*); Clarksburg (*glabra, tomentosa*); Gaithersburg (*tomentosa*); Lusby (*tomentosa*); St. Leonard (*tomentosa*); Silver Spring (*glabra*); Wheaton (*tomentosa*); Kemp Mill (*glabra*). MASSACHUSETTS: Bolton (*ovata*); Petersham (*ovata*). MISSISSIPPI: nr. Sessums, Oktibbeha Co. (*ovata*). NEW HAMPSHIRE: Seabrook (*ovata*). NEW JERSEY: Columbia (*tomentosa*). NEW YORK: Herkimer (*ovata*). NORTH CAROLINA: Fayetteville (*tomentosa*); Providence (*glabra, tomentosa*); Wise (*tomentosa*). OKLAHOMA: Sallisaw (*tomentosa*). PENNSYLVANIA: Pavia (*ovata*). SOUTH CAROLINA: Georgetown (*tomentosa*). TENNESSEE: Dandridge (*tomentosa*); Dickson (*tomentosa*); Jackson (*tomentosa*); Mohawk (*tomentosa*). VIRGINIA: Warren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*); Dinwiddie (*tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Rt. 81, Mile 13.9, Washington Co. (*ovata*). WASHINGTON, DC: National Arboretum (*glabra, tomentosa*); Walter Reed Army Medical Center (*tomentosa*). WEST VIRGINIA: Capon (*ovata*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. tuberidolum* examined.—ALABAMA: Auburn, IX-19–2000 (larvae). ARKANSAS: Beulah, IX-10–2004 (larva); Osage, IX-9–2004 (larva). MARYLAND: Beltsville, USDA Agricultural Research Center, IX-26–1993 & IX-11–1994 (larvae), IX-30–2003 (larvae; 2 ♀, pupae, em. IV-10–2004), IX-28–2005 (larva; pupal exuviae, 3 ♀, em. IV-12–2006); Gaithersburg, VII-20–2000 (larva); Wheaton, V-24–1993 (larvae). WASHINGTON, DC: National Arboretum, IX-22–1988 (larvae).

Caryomyia tubicola (Osten Sacken)

Cecidomyia tubicola Osten Sacken 1862: 192; Felt 1909:293 (*Caryomyia*).

Description.—*Gall* (Figs. 26, 74–77).—Common and widespread (Map 1) on *Eucarya hickories* and occasional on *C. cordiformis* of *Apocarya* section; found singly or in groups; 3–7 mm in height, on lower leaf, usually between veins, occasionally adjacent to a vein; elongate-cylindrical, usually erect, knurled at apex; shiny, with minute longitudinal ridges; green, yellow, brown, or black; base of tube abruptly conical, deeply set into, and tightly sheathed by thick, scabrous, leaf growth with sharp apical edge; larval chamber variable in length, occupying basal half to nearly entire length of tube, lateral walls thin, hard, firm,

with longitudinal ridges; distal part of cylinder not hollow, traversed from larval chamber to apex by thin fibrous bundle. This gall superficially resembles that of *C. subulata* but the shape of the base is different, that of *C. subulata* being deeply recessed rather than conical. The long shaft of both galls set them apart from other *Caryomyia* galls, but conical bases and leaf sheaths are also seen in galls of *C. melicrustum* and *C. striolacrustum*.

Adult: **Head:** Antenna with 12 flagellomeres, occasionally a short 13th without circumfila in male. Each of the regular 12 male flagellomeres (Fig. 237) scarcely binodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length; female flagellomeres (Fig. 238) with 2 horizontal circumfila connected by 2 vertical strands. Labella (as in Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. **Thorax:** Wing (Fig. 245), length 1.3–2.0 mm in male (n=10); 1.8–2.6 mm in female (n=10). **Male abdomen:** Third through seventh tergites each with posterior setae continuous across width in mostly single row; eighth tergite weakly sclerotized, with or without a few posterior setae. Genitalia (Figs. 247–248): hypoproct broadest posteriorly, divided into 2 rounded lobes, each with several apical setae, dorsal surface devoid of setulae on anterior half; apex and venter of aedeagus furrowed. **Female abdomen** (Figs. 258–259): Third through seventh tergites each with posterior setae continuous across width in mostly single row; eighth tergite more weakly sclerotized than preceding tergite, with posterior row of setae variable, from setae in continuous single row or only 1 to a few laterally, the setae not as long as on seventh tergite. Ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (Figs. 187–192): Antennal bases oblique in ventral view, converging anteriorly, each terminating in short, obtuse point. Face with anterolateral pair of horizontal incisions, their posterior lip slightly protruding. Frons and clypeus moderately protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.2–1.8 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 322) with acutely triangular anterior

tooth and elongate, linear shaft, usually broadened anteriorly. Papillae without setae, their bases not raised. Lateral papillae usually 1, occasionally 2, on each side of spatula. Only 4 dorsal papillae present on first 7 abdominal segments. Abdominal segments with verrucae present dorsally at midlength, occasionally more extensively but not prominent or only sparsely around lateral pairs of dorsal papillae, and with sharp spicules ventrally anterior to sternal papillae and at posterior end of segment. Terminal segment shorter than eighth. **Second instar** (Figs. 272–273): Length 1.7–1.2 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and elliptical shaft. Bases of dorsal and pleural papillae slightly raised, dorsal papillae with short setae, remainder asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Syntypes*: Larva(e) and galls from *Carya* sp., vic. Washington, DC, Osten Sacken. The larvae are presumed lost but several galls remain on each of three leaflets that are deposited in the USNM.

Etymology.—The name *tubicola* is a Latin noun meaning “tube dweller.”

Affinities.—The closest relative of this species is not apparent, but galls of *C. melicrustum* and *C. striolacrustum* also have conical bases that are set into a socket made by the surrounding leaf. Antennal bases of *C. tubicola* pupae are, however, unlike those of the other two species. Larvae of *C. tubicola* usually have the lateral papillae reduced to only one per side, the greatest known reduction in Cecidomyiidae.

Biological notes.—This may be the most common species of *Caryomyia*. While tubes of mature galls are usually about four times as long as wide, many are much shorter. Larval success does not appear to depend on gall length. In the Washington, DC area, adults emerge beginning the first week of April from galls collected the previous autumn. Pupae emerge from a weak area at the base of the tube that was scraped away by the larva in the previous season (Fig. 77). New galls are visible by mid-May as a thickening visible on both surfaces of the leaflets, but they are still green and the tube has not yet begun to elongate (Fig. 74). Additional, apparently new galls can be found through early August. First instars are translucent and elliptical and lie flat against what will become the base of the tube. As the gall grows, the exterior is quite hard but the base, hid-

den in the enveloping leaf collar, is initially soft until it grows to enclose the first instar. The larva then becomes more evenly cylindrical and migrates up the lengthening tube. By late May some tubes have begun to emerge from the basal boot. By mid-June some of the tubes have achieved their full length and the larvae have mostly molted to the more cylindrical second instar. By mid-July some galls contain third instars. The tubes mostly dehisce from the leaves before leaf drop. This species is one of the few that occurs on both the *Eucarya* and *Apocarya* sections, although to date I have found it only on *C. cordiformis* of the *Apocarya* group. Galls on *C. cordiformis* are never so common, dense, or robust as those on the *Eucarya* group, but more weak-walled galls may be a function of the thinner leaves of *C. cordiformis*. On *C. cordiformis* the galls are usually found along a vein.

Collections of galls.—**ALABAMA:** Ashville (*tomentosa*); Auburn (*ovata*, *pallida*, *tomentosa*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*ovata*, *pallida*). **ARKANSAS:** Beulah (*tomentosa*); Chester (*texana*); 2 mi S DeQueen (*texana*, *tomentosa*); 3 mi S Harrison (*tomentosa*); Osage (*texana*); Rt.1 at Red River, Little River Co. (*tomentosa*); Magazine Mt., Logan Co. (*ovata*, *texana*, *tomentosa*); Palestine (*ovata*); Piney (*texana*); Winslow (*ovata*). **CONNECTICUT:** Amston (*ovata*); Danbury (*ovata*); Harwinton (*ovata*); Litchfield (*ovata*); Meriden (*cordiformis*, *glabra*, *ovata*); New Haven (*glabra*); Oakville (*glabra*, *ovata*); Southbury (*cordiformis*, *glabra*, *tomentosa*); Phoenixville (*ovata*); Plainfield (*ovata*); Southington (*ovata*); Thomaston (*ovata*); Westchester (*ovata*). **FLORIDA:** Chattahoochee (*glabra*, *tomentosa*); Gainesville (*glabra*, *tomentosa*); Lake City (*tomentosa*); Ponce de Leon (*glabra*). **GEORGIA:** Carnesville (*glabra*); Forsyth (*glabra*, *ovata*); 8 km E Fort Valley Lake Park (*glabra*, *pallida*); Lizella (*ovata*, *tomentosa*). **ILLINOIS:** Dexter (*laciniosa*, *tomentosa*); Highland (*laciniosa*); Marshall (*tomentosa*). **INDIANA:** New Castle (*glabra*); Plainville (*cordiformis*, *tomentosa*); Richmond (*tomentosa*); Spencer Co. (*ovata*). **KENTUCKY:** Brownsville (*tomentosa*); Grayson Lake St. Pk, Carter Co. (*tomentosa*); Morehead (*tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*); Pennyrite St. Pk, Christian Co. (*glabra*, *ovata*); Winchester (*laciniosa*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*texana*). **MAINE:** Eliot (*tomentosa*); North Berwick (*ovata*). **MARYLAND:** Beaver Dam (*tomentosa*); Beltsville, USDA Agricultural

Research Center (*glabra, tomentosa*); Bethesda (*cordiformis*); Brighton (*tomentosa*); Cabin John (*cordiformis*); Calverton (*tomentosa*); Clarksburg (*tomentosa*); College Park (*glabra*); Ellicott City (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Kensington (*cordiformis*); Long Beach (*cordiformis*); Lusby (*glabra, tomentosa*); Potomac (*cordiformis, tomentosa*); Ridgely (*cordiformis, glabra, tomentosa*); St. Leonard (*tomentosa*); Silver Spring (*glabra, tomentosa*); Snow Hill (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*cordiformis, glabra, tomentosa*). MASSACHUSETTS: Great Barrington (*ovata*); Holyoke (*ovata*); Merrimac (*ovata*); Petersham (*ovata*); Wrentham (*ovata*). MISSISSIPPI: Natchez Trace Pkwy, Mile 193, Choctaw Co. (*pallida, tomentosa*); Noxubee Natl Wildlife Ref., Okfobeha Co. (*ovata, tomentosa*); nr. Sessums, Okfobeha Co. (*ovata*); 7 mi E Starkville (*pallida*); Vicksburg (*cordiformis*). MISSOURI: Conway (*ovata, texana*); Crowley Ridge Roadside Pk, Stoddard Co. (*glabra, tomentosa*); Holly Ridge State For., Stoddard Co. (*glabra, tomentosa*); Oregon Co., junc. Rts. 11 & 142 (*cordiformis*); Rolla (*texana*); St. Clair (*texana, tomentosa*); Wildwood (*tomentosa*). NEW HAMPSHIRE: Barrington (*ovata*); Dover (*ovata*); Kingston (*ovata*). NEW JERSEY: Columbia (*cordiformis, ovata, tomentosa*). NEW YORK: Albany (*Carya* sp.); East Schodack (*Carya* sp.) Herkimer (*ovata*); Hyde Park (*ovata*); Ithaca (*cordiformis, ovata*); Nassau (*Carya* sp.); New York (*Carya* sp., Beutemann 1904: 27, fig. 58); Nyack (*tomentosa*); Ravena (*ovata*); Saratoga Springs (*ovata*); Shokan (*glabra*). NORTH CAROLINA: Alamance (*tomentosa*); Alberta (*glabra*); Dorchies (*tomentosa*); Fayetteville (*tomentosa*); Gastonia (*tomentosa*); Providence (*glabra*) Rowland (*tomentosa*); Wise (*tomentosa*). OHIO: Hocking St. For., Hocking Co. (*tomentosa*); Hocking Co. (*Carya* spp., Wells 1916: Fig. 26); Huron Co. (*Carya* sp., Sears 1914: Fig. 19); St. Clairsville (*tomentosa*); Summerford (*tomentosa*); Yellow Springs (*glabra*). OKLAHOMA: Sallisaw (*tomentosa*). ONTARIO: Dundas (*ovata*). PENNSYLVANIA: Kirby (*ovata*); Julian (*glabra*); Millsboro (*glabra*); Mooresville (*tomentosa*); Pavia (*ovata*); Schellsburg (*glabra, ovata*). SOUTH CAROLINA: Dillon (*tomentosa*); Georgetown (*tomentosa*); Richland Co. (*Carya* sp.). TENNESSEE: Crossville (*pallida, tomentosa*); Dandridge (*tomentosa*); Dickson (*tomentosa*); Greene Co., I 81, Mile 38.5 (*ovata*); Jackson (*tomentosa*); Lebanon (*glabra*); Mohawk (*tomentosa*). TEXAS: Daingerfield St. Pk, Morris Co. (*tomentosa*); New Waverly (*tomentosa*). VIRGINIA: Dinwiddie

(*glabra, tomentosa*); Huntley Meadows Pk, Fairfax Co. (*tomentosa*); Ladysmith (*tomentosa*); Leesburg (*tomentosa*); Skippers (*tomentosa*); Warren Co., Blue Ridge Pkwy Mile 4.6 (*ovata*); Rt. 81, mi. 13.9, Washington Co. (*ovata*). WASHINGTON, DC: National Arboretum (*glabra, tomentosa*); Walter Reed Army Medical Center (*tomentosa*). WEST VIRGINIA: Beech Fork St. Pk, Wayne Co. (*ovata, tomentosa*); Cacapon (*ovata*); Cooper's Rock St. Pk, Preston Co. (*glabra*); Falling Waters (*cordiformis*); 6 mi NW Hedgesville (*glabra, ovata, tomentosa*).

Specimens of *C. tubicola* examined.—CONNECTICUT: Meriden, IX-30-1997, (larvae), IX-18-1998 (larvae; 2 ♂, em. V-1999); New Haven, IX-19-1994 (larvae); Phoenixville, IX-26-1994 (larva); Plainfield, VIII-27-1988 (larvae). GEORGIA: Fort Valley, IX-11-1993, J. & R. Payne (larva). KENTUCKY: Brownsville, IX-21-1995 (larvae). MAINE: North Berwick, IX-21-1994 (larva). MARYLAND: Beltsville, USDA Agricultural Research Center, IV-10-1997, V-26-1997, V-14-1998, VI-17-1998, VII-1-1998, VII-15-1998 & VIII-5-1998 (larvae), & IX-5-1991 (larvae; 4 ♂, 3 ♀, pupae, em. IV-25-1992); Bethesda, IX-15-1997 (larvae); Brighton, X-10-1993 (4 ♂, 5 ♀, pupae, em. IV-21 to 28-1994); Gaithersburg, V-23-2000 (larvae); Kensington, VII-27-2003 (larvae); Ridgely, X-2-2000 (♀, pupa, em. IV-2001), IX-11-2003 (2 ♂, 3 ♀, pupae, em. IV-10-2004), X-6-2005 (pupae, 2 ♂, 6 ♀, em. IV-10 to 21-2006); Silver Spring, IX-17-1993 (larvae); Wheaton, IX-28-1991, VII-18-1993 & IX-19-1993 (larvae). MASSACHUSETTS: vic. Worcester, M.T. Thompson (larva, 2 ♀). NEW YORK: East Schodack, E.P. Felt (larvae; ♂, ♀, em. V-19-30-1907); Nassau, E.P. Felt (larvae; ♂, ♀, em. IV 21-1908); Saratoga Springs, IX-25-1994 (larva). ONTARIO: Dundas, VIII-17-1995 (larvae). TEXAS: New Waverly, X-6-2001 (♂, 2 ♀, em. IV-2002). WEST VIRGINIA: 6 mi NW Hedgesville, IX-29-2002 (larvae). WASHINGTON, DC: National Arboretum, VIII-16-1988, IX-16-1988, IX-13-1991, IX-26-1991, V-28-1993, IX-22-1993, & IV-11-1997 (larvae), IX-24-1980 (♀, em. IV-1981), IX-24-1988 (3 ♂, 2 ♀, pupae, em. IV-1989), X-8-1991 (♂, 3 ♀, em. IV-25-1992), IX-30-1999 (2 ♂, 3 ♀, pupae, em. IV-2000), X-2001 (4 ♂, 1 ♀, em. IV-2002), & X-29-2002 (larvae; 8 ♂, 8 ♀, pupae, em. IV-2003).

Caryomyia tumida Gagné, new species

Description.—Gall (Figs. 104–105): Rare, known from only 2 collections, on *Eucarya hickories*; on lower leaf surface, between veins; 3 mm in

height, depressed-obconic, with small umbo at apex, made up of basal ovoid larval chamber and apical, much broader, false chamber; tan, rubbery, covered with short, decumbent hairs obscuring gall surface, not sticky; base of gall tapered to conical pedicel, leaf with slight exfoliation around gall connection forming short, tubular socket and on reverse side showing discolored convexity; wall thin, basal larval chamber separated from larger, apical false chamber by thin wall with umbo at center, both chambers longitudinally striate. The gall is shaped as for that of *C. inflata* but is covered with decumbent hairs in contrast to the completely hairless, glabrous gall of *C. inflata*.

Adult and pupa: Unknown.

Larva: Third instar: Length 1.7–2.2 mm (n=3). Body cylindrical, anterior and posterior ends rounded. Head directed anteroventrally. Spatula (as in Fig. 313) with anterior tooth about as wide as long, tapering from base to apex, almost triangular, obtusely notched at apex, the shaft long and narrow. Two lateral papillae present on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Papillae without setae, not raised. Abdominal segments with sparse pointed verrucae dorsally at midlength surrounding dorsal papillae and horizontal rows of sharp, pointed spicules ventrally, anterior to sternal papillae, but none posteroventrally. Terminal segment shorter than eighth. *Second instar:* Not seen, but, because of similarity between the gall of this species and that of *C. inflata*, may be expected to have short-haired dorsal and pleural papillae.

Type material.—*Holotype:* Third instar (right-most specimen of 3 larvae on slide), from gall on *Carya ovata*, Schellsburg, Pennsylvania, IX-2-2003, R.J. Gagné, deposited in USNM.

Etymology.—The name *tumida* is a Latin adjective meaning swollen, referring to the inflated false chamber of the gall.

Affinities.—See under *C. inflata*.

Collections of galls.—ILLINOIS: Rock Island (*tomentosa*; as *alba*, B.D. Walsh). PENNSYLVANIA: Schellsburg (*ovata*).

Specimens of *C. tumida* examined.—PENNSYLVANIA: Schellsburg, IX-2-2003 (larvae).

Caryomyia turbanella Gagné, new species

Description.—*Gall* (Figs. 132–133): Rare but widely distributed, on *Eucarya hickories*; on veins of upper leaf surface; length 4.0–5.0 mm, spher-

oidal, abruptly narrowed to conical apex; tan to purple, base with long, sparse, white hairs not obscuring surface, apical cone all or partly covered with small bumps and mostly hairless; base with circular, shallow, central excavation, leaf not exfoliate surrounding connection; larval chamber near base of gall, depressed-ovoid, lined with yellowish membrane, contrasting with brown to purple, large-celled, spongy, viscous tissue surrounding larval chamber that shrivels with maturity; a bundle of longitudinal fibers present between larval chamber and gall apex. The gall of this species is one of only two *Caryomyia* galls found exclusively on the upper leaf surface. It is distinctive for its hairy spheroidal base and bumpy conical apex.

Adult: Head: Antenna with 12 binodal flagellomeres, each of male flagellomeres (as in Fig. 239) with definite internode and neck, circumfila loops short, their bases widely separated; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. Wing length 4.2–4.3 mm in male (n=2), 2.5–3.3 mm in female (n=3). *Male abdomen:* Third to eighth tergites each with posterior setae continuous across width in mostly double row laterally, tapering to single row mesad, eighth tergite may have three setal rows laterally, the setae as strong as those of previous tergite. Genitalia (as in Figs. 256–257): hypoproct widened laterally to curve around sides of aedeagus, posterior margin setose, dorsal surface setulose only on posterior fourth; apex of aedeagus convex; gonostylus broad apically. *Female abdomen:* Third through eighth tergites as for male, setae of eighth tergite as long as on preceding tergite. Ovipositor: ninth segment pliable except for slender dorsal sclerite, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally; cerci ovoid in lateral view, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: Third instar: Length 1.8–2.2 mm (n=6). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spatula (Fig. 310) with long, nearly parallel-sided, api-

cally notched tooth and long shaft slightly widened anteriorly and parallel-sided beyond. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded verrucae covering dorsum at midlength and smaller, horizontal rows of spicules on venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Length 0.8–1.3 mm (n=9). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae not raised, asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—**Holotype:** Third instar, from gall on *C. tomentosa*, Entomology Road, BARC, Beltsville, MD, IX-26-1993, R.J. Gagné, deposited in USNM.

Etymology.—The name *turbanella* is a Latin noun meaning “little turban,” referring to the general shape of the gall.

Affinities.—See under *C. persicoides*.

Collections of galls.—**ALABAMA:** Greenville (*tomentosa*). **ARKANSAS:** Piney (*texana*). **CONNECTICUT:** Plainfield (*ovata*). **FLORIDA:** Gainesville (*glabra, tomentosa*). **GEORGIA:** 8 km E Fort Valley (*pallida*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra, tomentosa*); Brighton (*tomentosa*); Lusby (*tomentosa*); Ridgely (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra*).

Specimens of *C. turbanella* examined.—**ALABAMA:** Greenville, IX-21-2000 (larva). **ARKANSAS:** Piney, IX-10-2004 (larvae). **FLORIDA:** Gainesville (IX-21-2000). **GEORGIA:** 8 km E Fort Valley, X-11-1993, J. & R. Payne (larvae). **MARYLAND:** Beltsville, USDA Agricultural Research Center, IX-26-1993, VIII-5-1998, and IX-28-1999 (larvae); Brighton, X-23-1999 (larvae); Lusby, IX-15-2005 & IX-15-2005 (larvae). **WASHINGTON, DC:** National Arboretum, VIII-9-1994 (larvae; 2 ♂, 3 ♀, pupae, em. IV-1995).

Caryomyia turbinata Gagné, new species

Description.—**Gall** (Figs. 123–125): Occasional, found on *Eucarya* hickories; usually in groups, on lower leaf surface between veins; height 2.8–4.2 mm, obconic to spheroidal, widest at midlength or beyond, apical third eventually collapsing and becoming flat; surface brown to red, covered with

both short and long brown hair not quite obscuring surface, the hair darker and denser apically; base with narrow, circular, shallow, central depression, sometimes barely noticeable, the leaf not exfoliated surrounding connection, usually with small convex, discolored area on reverse leaf surface; larval chamber basal, depressed-ovoid, lined with yellowish membrane, tissue beyond larval chamber red, soft, with large and spongy cells. This gall is unique among *Caryomyia* galls for its obconic shape, but in other characters appears most similar to the conical galls because of the extraneous, soft tissue outside the pellicle-lined larval chamber.

Adult: **Head:** Antenna with 12 flagellomeres; male flagellomeres (as in Fig. 237) scarcely binodal, only slightly narrowed beyond basal circumfilum, circumfila loops short, subequal in length; female flagellomeres with 2 horizontal circumfila connected by 2 vertical strands. Labella (as in Fig. 242) separated from one another anteriorly, hemispherical, short-setose, short-setulose. Palpus 4-segmented. **Thorax:** Wing length 1.9–2.2 mm in male (n=3); 2.2–2.6 mm in female (n=4).

Male abdomen: Third through seventh tergites each with posterior setae continuous across width, in single row; eighth tergite weakly sclerotized, without posterior setae. Genitalia (as in Figs. 247–248): hypoproct broadest near apex, posterior edge convex, margin setose except in middle third, dorsal setulae only on distal third; aedeagus furrowed apically and ventrally. **Female abdomen:** Third through eighth tergites each with posterior setae continuous across width, in mostly single row, usually double laterally; eighth tergite not less sclerotized than seventh and setae nearly as long. Ninth segment pliable except for slender dorsal sclerite that widens apically to invest part of cerci, setae sparse laterally, mostly as long as cerci, setae more numerous ventrally. Cerci elongate-ovoid in lateral view, pointed apically, fused dorsally for about 1/2 length.

Pupa (as in Figs. 213–214): Antennal bases pyramidal, separate, acutely pointed apicolaterally. Face with anterolateral pair of horizontal incisions, their posterior lip protruding to form a craterlike concavity. Frons and clypeus strongly protruded ventrally. Abdominal terga with several anterior rows of enlarged spinules.

Larva: **Third instar:** Length 1.6–2.5 mm (n=10). Body cylindrical, anterior and posterior ends broadly rounded. Head directed anteriorly. Spat-

ula (Fig. 305) with long, nearly parallel-sided, apically-notched tooth and long shaft. Papillae without setae, their bases not raised. Lateral papillae 2 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Abdominal segments with rounded and pointed verrucae covering dorsum across midlength and horizontal rows of pointed spicules across venter anterior to sternal papillae and posterior to ventral papillae. Terminal segment shorter than eighth. **Second instar:** Not seen.

Type material.—*Holotype*: Third instar (right-hand specimen of two on slide), from gall on *C. tomentosa*, Entomology Rd, BARC, Beltsville, Maryland, IX-26-1993, R.J. Gagné, deposited in USNM.

Etymology.—The name *turbanata* is a Latin adjective that means top-shaped or obconic and refers to the gall shape of this species.

Affinities.—The gall is unique in *Caryomyia* because of its obconic shape, but the soft tissue of the distal half that eventually collapses brings to mind galls of, e.g., *C. persicoides* and *C. turbanella*. The male antennae and genitalia of the present species are quite different from the other two and more similar to the *C. sanguinolenta* group. The ovipositor is unlike that of either group, being similar to that of *C. inclinata* (Fig. 262).

Collections of galls.—**ALABAMA:** Auburn (*glabra, tomentosa*); Greenville (*tomentosa*); Oak Mt. St. Pk, Shelby Co. (*pallida*). **ARKANSAS:** Beulah (*tomentosa*); London (*tomentosa*); Osage (*texana*). **CONNECTICUT:** Amston (*ovata*); Phoenixville (*ovata*). **FLORIDA:** Gainesville (*glabra, tomentosa*). **GEORGIA:** Carnesville (*ovata*); Lizella, J. & R. Payne (*tomentosa*). **ILLINOIS:** Marshall (*tomentosa*). **INDIANA:** Spencer Co. (*ovata*). **KENTUCKY:** Brownsville (*tomentosa*). **LOUISIANA:** Lake Bistineau St. Pk, Webster Parish (*texana*). **MARYLAND:** Beltsville, USDA Agricultural Research Center, Beltsville (*tomentosa*); Clarksburg (*tomentosa*); Gaithersburg (*tomentosa*); Kemp Mill (*glabra*); Lusby (*tomentosa*); Ridgely (*glabra, tomentosa*); Lusby (*glabra, tomentosa*); Ridgely, (*tomentosa*); St. Leonard (*tomentosa*); Silver Spring (*tomentosa*); Wheaton (*tomentosa*). **MASSACHUSETTS:** Great Barrington (*ovata*); Petersham (*ovata*). **MISSISSIPPI:** Natchez Trace Pkwy, Mile 123, Rankin Co. (*tomentosa*); Noxubee Natl Wildlife Ref, Oktibbeha Co. (*tomentosa*). **MISSOURI:** Conway (*ovata, texana*). **NEW YORK:** East Hampton (*tomentosa*). **NORTH CAROLINA:** Alamance (*tomentosa*); Kannapolis (*tomentosa*); Rowland (*tomentosa*). **OKLAHOMA:** Sallisaw (*tomentosa*). **PENNSYLVANIA:**

NIA: Kirby (*ovata*). **TENNESSEE:** Dickson (*tomentosa*); Jackson (*tomentosa*). **TEXAS:** Daingerfield St. Pk, Morris Co. (*tomentosa*); New Waverly (*texana*). **VIRGINIA:** Dinwiddie (*tomentosa*). **WASHINGTON, DC:** Walter Reed Army Medical Center (*tomentosa*).

Specimens of *C. turbinata* examined.—**ARKANSAS:** Osage, IX-9-2004 (larvae). **FLORIDA:** Gainesville, IX-21-2000 (larvae). **GEORGIA:** Carnesville, IX-19-2000 (larvae). **KENTUCKY:** Brownsville, IX-21-1995 (larva). **MARYLAND:** Beltsville, USDA Agricultural Research Center, Beltsville, IX-26-1993 (larvae); Gaithersburg, X-4-1994 (larvae; ♀, pupae, em. IV-1995); Kemp Mill, X-1-2005 (larva); Lusby, IX-2003 (2 ♀, em. IV-2004); Ridgely, X-2-2000 (larvae), X-6-2005 (larvae; pupae, 12 ♀, em. IV-5 to 19-2006); Silver Spring, X-3-1993 (larvae; ♂, 2 ♀, pupae, em. IV-25 to 27, 1994) & X-23-1999 (larvae); Wheaton, IX-19-1993 (larvae). **MASSACHUSETTS:** Petersham, IX-6-2000 (larvae). **MISSOURI:** Conway, IX-8-2004 (larvae). **OKLAHOMA:** Sallisaw, IX-9-2004 (larvae). **PENNSYLVANIA:** Kirby, IX-6-2004 (larvae). **TENNESSEE:** Dickson, IX-11-2004 (larva). **TEXAS:** New Waverly, X-6-2001 (larva). **WASHINGTON, DC:** Rock Creek Park, IX-22-1993 (larvae).

Caryomyia urnula Gagné, new species

Description.—*Gall* (Figs. 28, 41-42): Late spring, early summer, common on the *Eucarya* section, rare on *Apocarya* section; found singly between veins on either upper or lower leaf surface; 2.0-3.0 mm in height, cylindrical, slightly bulging at midlength, narrowed abruptly apically to convex areola surrounding prominent nipple, surface smooth to weakly lined longitudinally; hairless, not sticky, white to green, turning dark green or brown; base shallowly concave; wall firm, brittle, uniformly thin, larval chamber glabrous with longitudinal ridges. This gall resembles that of *C. ciliolium* and relatives in the caplike apex and the central indentation of the base, but it is smaller, and more cylindrical than spheroid. The apex does not break off easily as it does in galls of *C. ciliolium* and relatives.

Adult: Unknown.

Pupa (Figs. 195-196): Antennal bases oblique in ventral view parallel, apices closely adjacent, rounded anteriorly, dorsoventrally flattened. Face with longitudinal impression running along length, a slight anteromesal convexity posterior to each antennal base, and without anterolateral pair

of horizontal incisions. Frons and clypeus slightly convex. Abdominal tergal spinules all similarly small.

Larva: Third instar: Length 1.6–2.1 mm (n=10). Body elongate-cylindrical, anterior and posterior ends rounded. Head directed anteriorly. Spatula (Fig. 276) with pointed anterior tooth and long linear shaft barely wider than tooth. Lateral papillae 1–3 on each side of spatula. Only 4 dorsal papillae on first 7 abdominal segments. Papillae without setae, their bases not raised. Abdominal segments almost completely covered with rounded verrucae dorsally and pointed verrucae ventrally. Terminal segment shorter than eighth. **Second instar:** Length 1.0–1.3 mm (n=10). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Bases of dorsal and pleural papillae slightly raised, asetose. Only 4 dorsal papillae on first 7 abdominal segments.

Type material.—*Holotype*: Third instar, from gall on *C. tomentosa*, Beltsville, Maryland, X-8-2002, R.J. Gagné, deposited in USNM.

Etymology.—The name *urnula*, a noun, is Latin for a small urn and refers to the shape of the gall.

Affinities.—The pupa is similar to that of the *C. cilidolum* group with the longitudinal central facial line and slight prominence posterior to the antennal bases, lack of a frontal projection, and lack of dorsal specialized spicules on the abdomen. The larva of *C. urnula*, although it has a single-toothed spatula and is completely covered with verrucae, has the head directed anteriorly, a shorter terminal larval segment, and a much less verrucose integument. These differences may only reflect the fact that the gall of *C. urnula* is more cylindrical than spheroidal, but a more important difference may be that the larva of *C. urnula* has only 4 dorsal papillae on the first through seventh abdominal segments while the *C. cilidolum* group has 6.

Biological notes.—This species is a generalist that occurs on both *Eucarya* and *Apocarya* sections and can be found on either leaf surface. Full-grown galls can be found any time from May through October and full-grown larvae anytime after early June, a time range unique for *Caryomyia*. Development of galls is evidently staggered. In late May through October in central Maryland, galls can be found with first, second, or third instars inside, and second instars can be

found in galls into late August. These galls appear to dehisce from the leaves as soon as the third instars mature, possibly because of the active larvae inside. Agitation by the full-grown larva in a dehisced gall causes the gall to pop up and down and roll on a level surface. Early dehiscence may be the reason the galls are uncommon on leaves in late season, although occasional galls with live third instars can be found through September and into October, at least in Maryland. In one September trip from Maryland through Arkansas to collect hickory galls, I found not a single example.

Collections of galls.—**ALABAMA:** Auburn (*ovata*); Birmingham (*pallida*). **Arkansas:** S Foreman (*illinoiensis*). **CONNECTICUT:** Phoenixville (*ovata*); Thomaston (*cordiformis*). **FLORIDA:** Alachua Co. (Hodges et al. 2006: bottom photo, upper half only). **GEORGIA:** Forsyth (*glabra*); 8 km E Fort Valley (*pallida*); Lizella (*ovata*). **KENTUCKY:** Grayson Lake St. Pk, Carter Co. (*ovata*); Pennyriile St. Pk, Christian Co. (*ovata*). **LOUISIANA:** Bistineau St. Pk, Webster Parish (*tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Clarksburg (*glabra*, *tomentosa*); Ellicott City (*cordiformis*, *tomentosa*); Gaithersburg (*tomentosa*); Lusby (*tomentosa*); Ridgely (*cordiformis*, *tomentosa*); Wheaton (*cordiformis*, *glabra*). **MISSOURI:** Cadet (*cordiformis*); Holly Ridge St. For., Stoddard Co. (*tomentosa*). **OHIO:** Hocking St. For., Hocking Co. (*glabra*); Hocking Co. (*tomentosa*, Wells 1916: Fig. 28). **TENNESSEE:** Gatlinburg (*ovata*). **VIRGINIA:** Leesburg (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*glabra*, *ovata*, *tomentosa*); Falling Waters (*cordiformis*).

Specimens of *C. urnula* examined.—**GEORGIA:** 8 km E Fort Valley, X-11-1993, J. & R. Payne (larva). **MARYLAND:** Beltsville, USDA Agricultural Research Center, V-30-1977, V-22-1994, V-26 & VI-4-1997, V-29-1998, VI-18-1999, V-16 & 28-2000, X-8-2002, & V-26-2004 (larvae), and VI-9-2004 (pupae taken from galls IV-1-2005); Clarksburg, V-23-2000 & V-26-2004 (larvae); Ellicott City, VI-8-2005 (larvae); Lusby, IX-16-2003 (larvae); Wheaton, V-22-2000 (larvae). **WASHINGTON, DC:** National Arboretum, V-24-1994 (larvae).

Caryomyia viscidolum Gagné, new species

Description.—*Gall* (Figs. 25, 43–45): Occasional, found on *Eucarya* hickories; on upper leaf surface, between veins; 3.0–4.1 mm in height,

spheroidal, longer than wide, base broadly rounded to truncate in profile, apex with small central nipple surrounded by extensive areola that eventually separates from gall; surface resinous, especially on young galls, sticky, smooth except for scattered minute resin dots, areola paler than surrounding surface; base with wide, deep, circular indentation; wall firm, brittle, almost uniformly thin, larval chamber glabrous, with longitudinal ridges. This gall and that of the unrelated *C. turbanella* are the only *Caryomyia* galls that occur exclusively on the upper leaf surface of hickories. For notes on galls of related species, see under *C. ciliolium*.

Adult: Head: Antenna with 12 flagellomeres, in male (as in Fig. 240) with short necks and evenly cylindrical, girdled by 8–9 more or less parallel, occasionally interconnected, appressed circumfila interspersed with setae and covered with setulae; in female (Fig. 241), circumfila anastomozing on venter. Labella (Fig. 243) fused, the pair united, semicircular, setulose but asetose. **Thorax:** Wing length 2.3 mm in male (n=1) 3.1–3.3 mm in female (n=2). **Male abdomen:** Third through seventh tergites each with posterior setae continuous across width in mostly double, partly triple row; eighth tergite weakly sclerotized, with small posterior setae. Genitalia (as in Fig. 251): hypoproct broadest posteriorly and expanded ventrally to partly cover sides of aedeagus, each of the 2 lobes with 2–3 apical setae, dorsal surface completely covered with setulae on anterior half; aedeagus tapering gradually from wide base to narrow apex, the tooth large, dorsoventrally compressed. **Female abdomen:** Third through seventh tergites each with posterior setae in 3 horizontal rows laterally, thinning to 2, then one, with slight medial interruption in setae; eighth tergite more weakly sclerotized than preceding tergite, with weak posterior setae numerous laterally, continuing mesally in single, sparse row. Ninth segment (Fig. 261) pliable except for slender dorsal sclerite, with numerous apicolateral and ventral setae, none longer than the cerci, the two groups separated laterally. Cerci elongate-ovoid in lateral view, pointed apically, fused dorsally for about 1/2 length.

Pupa (as in Figs. 193–194): Antennal bases elongate, in ventral view parallel, closely adjacent, rounded anteriorly, the apices dorsoventrally flattened. Face with longitudinal impression running along length, a slight anteromesal convexity pos-

terior to each antennal base, and without antero-lateral pair of horizontal incisions. Frons and clypeus slightly convex. Abdominal tergal spinules all similarly small.

Larva: Third instar: Length 2.5–3.2 mm (n=10). Body slightly dorsoventrally flattened, elongate-ovoid, broadly rounded anteriorly, spindleform posteriorly. Head directed ventrally, surmounted dorsally by collar segment. Spatula (Fig. 279) with pointed anterior tooth and long, broad shaft. Papillae on dorsum and pleura prominently raised above surrounding surface, without setae. Lateral papillae 2 on each side of spatula. Six dorsal papillae on first 7 abdominal segments. Body completely covered with verrucae. Terminal segment as long as eighth, rounded. **Second instar:** Length 1.0–1.8 mm (n=4). Collar segment with patch of enlarged spicules on each side. Spatula with acutely triangular anterior tooth and longer, wider, concave-sided shaft. Six dorsal papillae on first 7 abdominal segments. Bases of dorsal, pleural, terminal, and ventral papillae elongate, asetose.

Type material.—*Holotype*: Third instar (right-hand specimen of two on slide), from gall on *C. tomentosa*, Brunett Ave., Silver Spring, Maryland, IX-12-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *viscidolum*, a noun, combines the Latin *viscidus* (sticky) and *dolum* (jar) and refers to the resinous, barrel-like gall.

Affinities.—See under *C. ciliolium*.

Biological notes.—Pupae break out of the weak cap at the gall's apex. Emergence occurs in April.

Collections of galls.—**ARKANSAS:** Osage (*texana*); Palestine (*ovata*). **CONNECTICUT:** Danbury (*ovata*); Hartland (*ovata*); Harwinton (*ovata*); Litchfield (*ovata*); Meriden (*glabra, ovata*); Phoenixville (*ovata*). **ILLINOIS:** Marshall (*tomentosa*); Rock Island (*ovata, tomentosa*). **INDIANA:** New Castle (*glabra*). **KENTUCKY:** Grayson Lake St. Pk, Carter Co. (*ovata, tomentosa*); My Old Kentucky Home St. Pk, Nelson Co. (*ovata*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra, ovata, tomentosa*); Brighton (*ovata*); Ridgely (*glabra, ovata, tomentosa*); Silver Spring (*tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra*). **MASSACHUSETTS:** Bolton (*ovata*); Great Barrington (*ovata*); Magnolia (*Carya sp.*); Merrimac (*ovata*); vic. Worcester (*Carya sp.*, Thompson 1915: 89, Fig. 218). **MISSISSIPPI:** nr. Sessums, Oktibbeha Co. (*ovata*). **NEW HAMPSHIRE:** Barrington (*ovata*); Seabrook (*ovata*). **NEW JERSEY:** Columbia (*ovata*). **NEW YORK:** Herkimer (*ovata*).

NORTH CAROLINA: Alberta (*glabra*). **OHIO:** Hocking St. For., Hocking Co. (*ovata*); Hocking Co. (*glabra*, Wells 1916: Fig. 25); St. Clairsville (*tomentosa*). **PENNSYLVANIA:** Julian (*glabra*). **VIRGINIA:** Huntley Meadows Pk, Fairfax Co. (*tomentosa*). **WASHINGTON, DC:** National Arboretum (*glabra*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*ovata*, *tomentosa*); 6 mi NW Hedgesville (*ovata*, *tomentosa*).

Specimens of *C. viscidolum* examined.—**CONNECTICUT:** Hartland, IX-7-2005 (1 ♂, pupal exuviae, em. IV-19-2006). **ILLINOIS:** Marshall, IX-7-2004 (larva). **MARYLAND:** Beltsville, USDA Agricultural Research Center, IX-26-1993 & VII-1-2000 (larvae); Brighton, IX-6-2002 (♀, pupa, em. IV-2003); Silver Spring, IX-12-1999 (larvae) & X-2003 (larvae; 2 ♀, pupae, em. IV-10-2004); Wheaton, VII-3-1994 and IX-4-1994 (larvae). **MASSACHUSETTS:** Great Barrington, IX-6-2000 (larva). **OHIO:** St. Clairsville, IX-6-2004 (larva). **WASHINGTON, DC:** National Arboretum, X-13-1997 (larvae). **WEST VIRGINIA:** 6 mi NW Hedgesville, IX-19-1999 & VII-23-2000 (larvae).

GENUS CARYADIPLOYSIS GAGNÉ, NEW GENUS

Type-species, *Caryadiplosis venicola* Gagné, by present designation.

Diagnosis.—This genus differs from other genera of Cecidomyiidae by the following combination of characters: Adult without dorsal protuberance on occiput; costal wing vein unbroken at juncture with R_5 ; gonostylus short, broad, fully setulose, with wide tooth; protrusible ovipositor short; female ninth tergite dorsally with narrow, pigmented, stiff, dermal structure; cerci discrete, bilaterally flattened, discoid, without distal pair of trichoid sensilla. Larva *Contarinia*-like, with full complement of papillae for supertribe (Gagné 1994), terminal segment with 1 pair of corniform, recurved papillae and three pairs with short setae.

Description.—**Adult:** **Head:** Eyes connate. Occiput without dorsal protuberance. Palpus with 3 to 4 segments. Labrum with short setae on venter. Labella discrete, nearly hemispherical but blunt at apex, setulose, setose. Antenna with 12 flagellomeres: male flagellomeres (Fig. 328) binodal, internodes and necks short, with 3 circumfila, 1 on basal node and 2 on distal node, loops of circumfila subequal in length; female flagellomeres (Fig. 329) with cylindrical node and, except for last fla-

gellomere, short necks, each node with 2 horizontal, appressed circumfila connected by 2 vertical strands. **Thorax:** Scutum with 4 longitudinal rows of setae. Scutellum with lateral group of setae on each side. Pleura hairless except for anepimeron. Wing: length 2.0–2.3 times width; C unbroken at juncture with R_5 (as in Fig. 245); R_5 curved apically, joining C near wing apex; Rs detectable only as stump on R_5 and situated closer to arculus than to R_1 . Legs 0.9–1.1 length of wings; tarsal claws untoothed, curved beyond midlength; empodium as long as claws; pulvilli about 1/4 length of claws. **Male abdomen** (Fig. 330): First through seventh tergites entire, rectangular, about 5 times as wide as long; with single row of setae along posterior margin, interrupted mesally on seventh tergite; an extensive lateral group of setae on each side near midlength with sparse, setiform scales intermixed, the two lateral groups almost joining mesally, and anterior pair of trichoid sensilla; eighth tergite weakly sclerotized, short, 2 lateral papillae on each side and anterior pair of trichoid sensilla the only vestiture; sternites rectangular, about as wide as long, second through seventh with single horizontal row of setae posteriorly except seventh with double row, a large group of setae near midlength, and 2 closely adjacent trichoid sensilla anteriorly; eighth sternite with several rows of setae posteriorly, bare anteriorly except for 2 widely separated trichoid sensilla. **Genitalia** (Figs. 332–333): cerci convex at apex, setose along posterior margin; hypoproct slightly longer than cerci, divided into 2 rounded, posteriorly setose lobes, with ventral setulae throughout; horizontal ridge at midlength; aedeagus broad, slightly longer than hypoproct; gonocoxite bulbous; gonostylus short-ovoid, evenly setose, completely setulose. **Female abdomen** (Fig. 331): First through seventh tergites as for male, eighth tergite with complete, mostly single row of posterior setae; sternites also as for male, except eighth not well defined, the pair of anterior trichoid sensilla of that sclerite widely separated, the posterior setae scattered; ovipositor short, protrusible, abruptly tapered beyond extension of eighth segment; ninth tergite with narrow, pigmented sclerite, otherwise moderately covered with short, scattered setae; cerci ovoid, covered with dense setae but without peglike sensilla; hypoproct short, broad, with 2 posterior setae.

Pupa: Unknown.

Larva: **Third instar** (Figs. 334–337).—Cylindri-

cal, anterior end tapered, posterior end broadly rounded. Head directed anteriorly, apodemes longer than head capsule. Antenna about twice as long as wide. Spatula clove-shaped. Lateral papillae on each side of midline in two triplets, two of each group with short setae, the third slightly larger in diameter, without seta. Dorsal and pleural papillae with minuscule setae. Terminal segment with four pairs of papillae, one pair corniform, recurved, one pair situated between corniform pair with short setae, two pairs placed laterad, with short setae. **Second instar** (not seen).

Etymology.—The name *Caryadiplosis* combines *Carya*, the name of the host genus, with “diplosis,” meaning “double,” with reference to the bimodal male flagellomeres. The suffix is commonly used for genera of the supertribe Cecidomyiidi.

Affinities.—*Caryadiplosis* belongs to the supertribe Cecidomyiidi, chiefly because of the two distinct nodes and separate many-looped circumfila of the male flagellomeres and the lack of setae on the ventral papillae of the larval abdomen. It belongs to the tribe Cecidomyiini because the adult has simple tarsal claws that are curved beyond midlength and the larval terminal segment has one pair of corniform, recurved papillae and three setiform pairs.

The new genus shares with *Caryomyia* the following character states that appear to be synapomorphic: Wing unbroken at junction of R₅ and C; anepisternum without vestiture; gonostylus ovoid and entirely covered with setulae; ovipositor short-cylindrical and abruptly narrowed between eighth and ninth segments, the ninth segment with a dorsal, elongate, stiff, dark-pigmented sclerite along its entire length, and cerci lacking a distal pair of peglike sensilla.

Caryadiplosis differs from *Caryomyia* in the following ways: adult abdominal tergites have lateral setae (a group separate from the posterior setae) that are absent in *Caryomyia*; adult sternites have the anterior pair of trichoid sensilla that are lost in *Caryomyia*; larvae have six lateral papillae on each side of the midline, in two groups of three each, as do most Cecidomyiini, but the discrete grouping and at least three of the papillae are lost in *Caryomyia*; larval terminal papillae comprise a pair of corniform papillae and three pairs of setose papillae, as do most Cecidomyiini, but that are all merely flat or convex and asetose in *Caryomyia*; larvae drop to the soil to pupate unlike

those of *Caryomyia* whose larvae pupate in the galls.

It is fortunate that this genus was found during this study because it serves as a bridge between *Caryomyia* and *Contarinia* and relatives. Despite the many striking differences between *Caryadiplosis* and *Caryomyia*, the two genera share the presumably synapomorphic features outlined above. If one assumes a close affiliation between the two genera, it appears that *Caryomyia* separated from *Caryadiplosis* while already on hickories and that the greatly modified larvae of *Caryomyia* are a response to their passage from simple to complex galls and from pupating in the soil to pupating in the galls.

In the key to Nearctic genera of Cecidomyiidae in Gagné (1981), *Caryadiplosis* will run to *Paradiplosis* in the first half of couplet 146, except for the host indication, as *Paradiplosis* spp. are pests of fir and spruce. The two genera differ in the setation of the second through seventh adult abdominal tergites: those of *Caryadiplosis* have 10 or more lateral setae on each side in one or two rows that almost meet medially and are intermixed with setiform scales; the tergites of *Paradiplosis* have only 3–5 lateral setae close to the lateral margin and no scales. Differences between females are more striking: in *Caryadiplosis* the ovipositor is barely longer than the seventh tergite, while in *Paradiplosis* it is as long as the rest of the abdomen. In addition, female cerci of *Paradiplosis* have an apical pair of setae differentiated from the remainder by their thickness and larger socket, but cerci of *Caryadiplosis* have no such differentiated cerci. Interestingly, in both genera the costal wing vein is unbroken at its juncture with R₅ and the gonostylus is completely setulose, similarities that beg the question of affinity between the two genera.

SPECIES TREATMENTS

Caryadiplosis biconvexa Gagné, new species

Description.—**Gall** (Figs. 33, 167–169): Common, on both *Eucarya* and *Apocarya* sections; circular swelling, ca. 3.5 mm in diameter, on lamina, showing on both sides of leaflet; similar in color and texture to leaf, but some mature galls may turn black before larva escapes; wall of uniform thickness, larval chamber circular, flattened, reflecting

gall shape; full-grown larva exits gall from small hole in center of gall on abaxial leaflet surface.

Adult (only female known): Head: Eyes about 6 facets long at vertex; facets mostly circular, closely adjacent except slightly farther apart at midheight of head. Frons with 5 setae per side. **Thorax:** Pleura hairless except for anepimeron with 8–10 setae. Wing length 1.9–2.0 (n=2). **Female abdomen:** As for *C. venicola*.

Pupa: Unknown.

Larva: Third instar: White at first, turning to yellow during third instar, body cylindrical, anterior end tapered, posterior end broadly rounded. Head directed anteriorly, with apodemes longer than head capsule. Antenna about twice as long as wide. Spatula (Fig. 337) with anterior tooth composed of two elongate, rounded lobes, and with long posterior shaft. Integument on dorsum without sculpturing, on pleura with pointed verrucae anterior to spiracles, and on venter with horizontal rows of sharp spicules anterior to sternal papillae. Lateral papillae on each side of midline in two triplets, two of each group with short seta, the third larger and without seta. Dorsal and pleural papillae with very short setae. Terminal segment (Fig. 336) covered dorsally with verrucae, with four pairs of papillae, one pair corniform, recurved, one pair situated between corniform pair with tiny setae, two pairs placed laterad with short setae and situated on short lobes.

Type material.—**Holotype:** Larva, ex biconvex gall on *C. tomentosa*, National Arboretum, Washington, DC, X-8-1991, R.J. Gagné, deposited in USNM.

Etymology.—The name *biconvexa* is an adjective from the Latin with reference to the lens-shaped gall visible on both sides of a leaflet.

Affinities.—The larval terminal segment has dorsal verrucae in contrast with the smooth preceding segments. This is an effective character for separating this species from *C. venicola*. The two species are further separated by the terminal papillae all being situated on lobes in *C. biconvexa* and the lack of such lobes on *C. venicola*.

Biological notes.—Small circular galls with first instars were found as early as May 26 in central Maryland. On both June 5 and 9 yellow galls were found with full grown larvae or from which larvae had already escaped, indicating that development is swift. Possibly this species has more than one generation per year because galls with first instars

were found as late as Sept. 11 and second and third instars on Sept 26, but the galls seemed not as common in late summer as in spring. Larvae exit from the lower surface of the leaflet.

Collections of galls.—(The small number of collections does not reflect how common this species is because I did not always make a note of old galls). **ALABAMA:** Auburn (*aquatica*); Greenville (*tomentosa*). **ARKANSAS:** London (*cordiformis*). **GEORGIA:** Forsyth (*ovata*). **INDIANA:** Richmond (*cordiformis*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra*, *tomentosa*); Calverton (*tomentosa*); Clarksburg (*tomentosa*); College Park (*glabra*); Ellicott City (*cordiformis*, *tomentosa*); Long Beach (*cordiformis*); Lusby (*tomentosa*); Piney Grove (*ovata*); Ridgely (*glabra*, *tomentosa*); Spencerville (*tomentosa*); Wheaton (*glabra*). **MASSACHUSETTS:** Peter-sham (*ovata*). **NEW YORK:** Hyde Park (*ovata*); Nassau (*Carya* sp.). **NORTH CAROLINA:** Alberta (*glabra*). Kannapolis (*tomentosa*); Providence (*tomentosa*). **OHIO:** Vinton Co. (*cordiformis*, Wells 1916: Fig. 33). **OKLAHOMA:** Sallisaw (*tomentosa*). **PENNSYLVANIA:** Millsboro (*glabra*). **TENNESSEE:** Dickson (*tomentosa*); Jackson (*tomentosa*). **WASHINGTON, DC:** (*tomentosa*). **WEST VIRGINIA:** Falling Waters (*cordiformis*).

Specimens of *C. biconvexa* examined.—**MARY-LAND:** Beltsville, USDA Agricultural Research Center, VI-14 & 29-2000 & VII-12-2000 (larvae), VI-15-2004 (2 ♀, em. IV-20-2005); Calverton, X-10-2005 (larvae); Clarksburg, X-4-2005 (larvae); Ell-icott City, IX-2-2000 (larvae). **NEW YORK:** Nassau, X-3-1907, E.P. Felt (larva). **WASHINGTON, DC:** National Arboretum, X-8-1991 (larva); Walter Reed Army Medical Center, IX-26-2005 (larvae). **WEST VIRGINIA:** Falling Waters, VI-21-2004 (larvae).

Caryadiplosis venicola Gagné, new species

Description.—**Gall** (Figs. 165–166): Occasional, on both *Eucarya* and *Apocarya* sections; an elongate, hard swelling of midvein or petiole, usually showing on both sides of leaflet, 5 mm long, 2 mm high when single chambers, longer and broader when several chambers are in tandem; exterior tan to brown, rough; wall of uniform thickness; larval chamber elongate; an exit hole eventually develops on lower leaf surface through which the full-grown larva falls to ground.

Adult: Head: Eyes about 6 facets long at vertex; facets mostly circular, closely adjacent except slightly farther apart at midheight of head. Frons

with 3–5 setae per side. **Thorax:** Pleura hairless except for anepimeron with 7–9 setae. Wing length 2.0 mm in male (n=1); 2.3–2.5 mm in female (n=3). **Male abdomen:** Segments 6–8 as in Fig. 330; genitalia, Figs. 332–333. **Female abdomen:** Segments 8 to end, Fig. 331.

Pupa: Unknown.

Larva: **Third instar:** Orange. Spatula (Fig. 335) with anterior end deeply divided into two elongate, subtriangular lobes and with long posterior shaft. Integument on dorsum without sculpturing, on pleura with pointed verrucae anterior to spiracles, and on venter with horizontal rows of sharp spicules anterior to sternal papillae. Terminal segment (Fig. 334) smooth on dorsum, without verrucae, with four pairs of papillae, one pair corniform, recurved, one pair situated between corniform pair with short setae, two pairs placed laterad, with short setae, not situated on short lobes.

Type material.—**Holotype:** Larva, middle of 3 specimens on slide, ex midrib swelling on *C. cordiformis*, Ridgely, Maryland, IX-23-1999, R.J. Gagné, deposited in USNM.

Etymology.—The name *venicola*, noun from the Latin meaning vein inhabitant, refers to the gall site.

Affinities.—See under *C. biconvexa* for characters to separate larvae of that species from *C. venicola*.

Biological notes.—My earliest-season sighting of galls in central Maryland was on July 22. I noticed them more commonly in Maryland and elsewhere in late August and September. Larvae left the galls on collected leaves in autumn, burrowed into the soil, and spun cocoons. In early April the following year, full-grown pupae found their way to the surface of the soil and adults emerged.

Collections of galls.—**ARKANSAS:** Beulah (*tomentosa*); Chester (*texana*); Osage (*tomentosa*); Piney (*texana*). **FLORIDA:** Gainesville (*glabra, tomentosa*). **GEORGIA:** Forsyth (*glabra*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Cabin John (*cordiformis*); Ellicott City (*tomentosa*); Long Beach (*cordiformis*); Lusby (*tomentosa*); Ridgely (*cordiformis, tomentosa*). **MISSOURI:** (*tomentosa*). **NORTH CAROLINA:** Wise (*tomentosa*). **OHIO:** Yellow Springs (*glabra*). **OKLAHOMA:** Sallisaw (*tomentosa*). **TENNESSEE:** Crossville (*pallida*); Jackson (*tomentosa*); Mohawk (*tomentosa*). **WEST VIRGINIA:** Falling Waters (*cordiformis*).

Specimens of *C. venicola* examined.—**ARKANSAS:** Osage, IX-9-2004 (larvae); Piney, IX-10-2004 (larva; ♂, 3 ♀, em. IV-6/10-2005). **MARYLAND:** Cabin John, VIII-26-2004 (larvae); Ellicott City, IX-2-2000 (larva); Long Beach, IX-15-2005 (larvae); Lusby, IX-15-2005 (larvae); Ridgely, IX-23-1999 & IX-11-2003 (larvae). **OHIO:** Yellow Springs, IX-7-2004 (larvae). **WEST VIRGINIA:** Falling Waters, IX-10-2005 (larvae).

GENUS CONTARINIA RONDANI

Contarinia Rondani 1860: 289. Type species, *Tipula loti* De Geer, by original designation; Gagné 2004: 108 (catalog).

Contarinia is a large genus of more than 300 species, most of which are found in flower heads or marginal leaf rolls. Very few of them are found in complex galls. Two species are placed in *Contarinia* here only in the broad sense because adults, not yet known for both, are needed for strict generic assignment. Various other genera of Cecidomyiini, including *Caryadiplosis* and *Hammandiola*, have larvae generally similar to *Contarinia* (Gagné 1989).

SPECIES TREATMENTS

Contarinia bulliformis Gagné, new species

Description.—**Gall** (Figs. 170–171): On pecan, *Apocarya* section; a bubble-like swelling of mid-vein or petiole, usually showing on both sides of leaflet, about 1 cm long, 3 mm high; green, smooth; wall of uniform thickness, larval chamber of same shape as gall, containing one to several larvae.

Adult and pupa: Unknown.

Larva: **Third instar:** Yellow, body cylindrical, anterior end tapered, posterior end tapering but truncate at end. Head directed anteriorly, apodemes as long as head capsule. Antenna about twice as long as wide. Spatula (Fig. 342) with anterior teeth pointed, their bases bulging slightly at lateral angles and with long posterior shaft. Integument on dorsum without sculpturing but with horizontal rows of verrucae anterior to dorsal papillae, on pleura with pointed verrucae anterior to spiracles, and on venter with horizontal

rows of sharp spicules anterior to sternal papillae. Lateral papillae on each side of midline in two triplets, two of each group with short seta, the third of slightly larger diameter and without seta. Dorsal and pleural papillae with setae no longer than wide. Terminal segment (Fig. 341) mostly covered dorsally with pointed verrucae, with four pairs of papillae all situated at the end of cylindrical lobes, one pair large, corniform, recurved dorsally, the pair situated between corniform pair with well-developed setae 3 times as long as wide, one lateral pair with setae 4 times as long as wide, the remaining lateral pair with minute setae no longer than wide. **Second instar:** (not seen).

Type material.—*Holotype:* Larva, ex bubble swelling on leaf vein of *C. illinoiensis*, Greensleeves Orchard, Caddo Parish, Louisiana, V-5-1982, Hall & Stoetzel, deposited in USNM.

Etymology.—The name *bulliformis*, an adjective from the Latin meaning bubble-shaped, refers to the gall form.

Affinities.—This species does not appear for now to fit in *Caryadiplosis* because papillae of the terminal segment are all situated on cylindrical lobes and four of the papillae have fairly long setae. In *Caryadiplosis* the terminal setae are minute and the subtending lobes are small or nonexistent. In addition, the spatula lobes of *C. bulliformis* are pointed rather than rounded. This is one of only two species of *Contarinia* (sensu lato) taken from hickories. It differs from more typical *Contarinia* spp. by the distinct lobes subtending all of the terminal papillae.

Biological notes.—This species was found by Manya B. Stoetzel in the course of her field work on *Phylloxera* on pecan. Nothing further is definitely known of the biology of this species, but the full-grown larvae probably escape the galls to drop to the soil.

Collections of galls and specimens of *C. bulliformis* examined.—LOUISIANA: Greensleeves Orchard, Caddo Parish, V-5-1982, Hall & Stoetzel, 4 larvae (including holotype).

Contarinia cucumata Gagné, new species

Description.—*Gall* (Figs. 29, 172–174): Infrequent, on *Eucarya* and *Apocarya* sections; on lower leaf surface, adjacent to vein; 3.6–5.0 mm in length, constricted at point of attachment to leaf, cylindrical and decumbent beyond, convex api-

cally, not dehiscent; surface rough, green becoming yellow, then brown, with many scattered, long, fine, white hairs not obscuring surface; base initially crimped, opening to upper surface of leaf when mature; wall thin, at first soft, later brittle, larval chamber rough.

Adult and pupa: Unknown.

Larva: *Third instar:* White, body cylindrical, anterior end tapered, posterior end broadly rounded. Head directed anteriorly, with apodemes longer than head capsule. Antenna about twice as long as wide. Spatula (Fig. 339–340) with anterior end divided into two triangular lobes (Fig. 339) that become rounded (Fig. 340) with use, and long posterior shaft. Integument on most of dorsum without sculpturing, on pleura with pointed verrucae anterior to spiracles, and on venter with horizontal rows of sharp spicules anterior to sternal papillae. Lateral papillae on each side of midline in two triplets, two in each triplet with short seta, the third slightly larger in diameter and without seta. Dorsal and pleural papillae with very short setae. Terminal segment (Fig. 338) covered dorsally with pointed verrucae, with four pairs of papillae, one pair corniform, recurved, one pair situated between corniform pair with tiny setae, two pairs placed laterad, situated on short lobes, with tiny setae. **Second instar:** (not seen).

Type material.—*Holotype:* Third instar (middle of 3 specimens on slide), ex leaf gall, *C. tomentosa*, Clarksburg, Maryland, V-26-2004, R.J. Gagné, deposited in USNM.

Etymology.—The name *cucumata*, an adjective, is a shortened version of the Latin *cucumerata*, meaning cucumber-like, with reference to the gall's general resemblance to a cucumber.

Affinities.—Larvae of *Caryadiplosis venicola*, also on hickory, are generally similar to this species, but young third instars of *C. venicola* have rounded spatula teeth while those of *C. cucumata* have pointed teeth. *Contarinia cucumata* is further distinguished by the complex gall it causes; most *Contarinia* spp. make no gall or simple ones, such as leaf rolls.

Biological notes.—This species shows wear of its spatula while still in the gall. Figs. 339–340 show the spatula of a newly molted third instar and an older one. The spatula of the newly molted larva is not yet entirely hardened or pigmented. In central Md, galls were first noticed on May 23 when still only bubble-like and containing first in-

stars. Galls were greenish white to light green, somewhat sticky, and covered with close, long white hairs. In subsequent days these hairs became farther apart as the gall quickly elongated along the leaf axis and became darker green. Larvae developed quickly and began to leave the galls by June 9 through the newly opened exit aperture on the upper side of the leaf. Mature larvae are white and active.

Collections of galls.—**ALABAMA:** Auburn (*ovata, tomentosa*); Oak Mt. St. Pk, Shelby Co. (*tomentosa*). **FLORIDA:** Gainesville (*tomentosa*). **GEORGIA:** 8 km E Fort Valley (*pallida*). Lizella (*tomentosa*). **KENTUCKY:** Brownsville (*tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*tomentosa*); Brighton (*tomentosa*); Clarksburg (*tomentosa*); Gaithersburg (*tomentosa*); Lusby (*tomentosa*); Ridgely (*cordiformis*); Wheaton (*tomentosa*). **MISSISSIPPI:** 7 mi E Starkville (*tomentosa*). **MISSOURI:** Cadet (*tomentosa*, C.V. Riley). **NEW YORK:** Albany (*Carya* sp.). **OHIO:** Hocking Co. (*glabra*, Wells 1915; Fig. 29). **TENNESSEE:** Dickson (*tomentosa*). **VIRGINIA:** Rt. 81, mi. 13.9, Washington Co. (*ovata*). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co. (*tomentosa*)

Specimens of *C. cucumata* examined.—**MARYLAND:** Clarksburg, V-23-2000, V-26-2004 & VI-9-2004 (larvae). **MISSOURI:** Cadet, VI-8-1890, B.D. Walsh (larva). **WEST VIRGINIA:** Beech Fork St. Pk, Wayne Co., VII-18-1988 (larva).

Abdomen (Figs. 346-347): First through seventh tergites rectangular, each with pair of anterior trichoid sensilla, single, sparse row of posterior setae, and covered with scattered scales, these sparse on seventh tergite; eighth tergite triangular or trapezoid, with anterior pair of trichoid sensilla and scattered short setae posteriorly and laterally beyond sclerotized portion; eighth segment ringed posteriorly by single row of short setae. Second through seventh sternites rectangular, with anterior pair of trichoid sensilla, single row posterior setae except seventh sternite with single row of setae at midlength and scattered scales elsewhere. Ovipositor (Fig. 346) short, the protrusible half no longer than twice length of seventh tergite and with setae present laterally and ventrally; cerci (Fig. 337) fused into single lobe, with 8 peglike setae apically and scattered setae elsewhere; hypoproct long, narrow, with 2 posterior setae.

Pupa: Unknown.

Larva: Third instar (Figs. 232-234, 349-350).—Body depressed-cylindrical, ends tapering. Head directed anteriorly, with short apodemes. Antenna less than twice as long as wide. Spatula evident only as short, triangular sclerite. Dorsal papillae 6 on each segment, with long setae, those of first thoracic and eighth abdominal segments set on slightly raised papillae, those of remaining segments set at ends of long lobes: the inner pair on separate triangular lobes, the outer pairs each on a single, broad, apically bifid lobe. Pleural papillae with long setae, as long as dorsals, set on slightly raised lobes. Sternal papillae without se-

GENUS GLASPILOTA GAGNÉ, NEW GENUS

Type-species, *Cecidomyia glutinosa* Osten Sacken, by present designation.

Diagnosis.—This genus belongs to the cecidomyiine supertribe Lasiopteridi because of the presence of setae on the ventral papillae of the larval eighth tergum. This genus is unique for the dissimilar tarsal claws, which may or may not have teeth, regardless of the leg they are on. The third instar is strongly modified for life in a liquid medium and is unique among Lasiopteridi for its dorsal abdominal lobes and the long setae of the dorsal and pleural papillae.

Description.—*Adult* (only female known): **Head:** Eyes connate. Occiput without dorsal protuberance. Frons with setae. Labrum without setae. Labellum separate, hemispherical, setose, and covered with setulae. Palpus 4-segmented. An-

tae. Lateral papillae very small, in two sets on each side of midline, an outer group of 3 papillae, each with seta, two of them smaller than the third, and an inner singlet with short seta. Ventral papillae each with short seta. Terminal segment with eight papillae, each with seta somewhat shorter than dorsals, one pair shorter than remaining three. **Second instar** (Fig. 348): Body cylindrical. Spiracles raised on prominences. Papillae with setae as for third instar but setae not appreciably longer than papillary bases and none with lobes.

Etymology.—The name *Gliaspilota* is coined from the Greek *glia* (= glue) and *spilos* (= spot), with reference to the sticky leaf spot formed by the only included species. The name is feminine.

Affinities.—The new genus belongs to the cecidomyiine supertribe *Lasiopteridi* because of the presence of setae on the ventral papillae of the larval eighth tergum. The adult female (the male is unknown) is superficially similar to *Dasineura* except for its very short ovipositor and undivided eighth tergite. Most *Dasineura* spp. have a long ovipositor and a longitudinally divided eighth tergite. The female of one species, *Dasineura rhois* Coquillett, only tentatively assigned to *Dasineura*, also has a short ovipositor and the eighth tergum shaped as in *Gliaspilota*, but differs from *G. glutinosa* in having separate cerci. Fused cerci and separate cerci do not necessarily preclude these two species from belonging in the same genus, inasmuch as *Oligotrophus* (*sensu stricto*) includes a pair of closely related species, one with fused cerci, the other separate (Sylvén & Tastás-Duque 1993), but the larvae of *G. glutinosa* and *C. rhois* are too different to consider as close relatives. Third instars of *G. glutinosa* are unique among *Lasiopteridi* for their dorsal abdominal lobes and the long setae of the dorsal and pleural papillae. These are characters evidently derived for life in resinous liquid and are analogous to the dorsal lobes seen in some species of *Cecidomyia* that live immersed in pine resin but belong to the supertribe *Cecidomyiidi*. The tarsal claws of *G. glutinosa* are unique among *Cecidomyiinae* in that the presence of teeth on the tarsal claws follows no rules: the fore, mid, and hind claws may be toothed or not, and both states may be present on separate claws of the same acropod.

Larvae of another genus of *Lasiopteridi*, *Acericecis*, also live in plant exudate on open galls of leaves of *Acer* spp. (Gagné 1983, Harris 2004), but

that genus shows no close connection to *Gliaspilota*. The wings of *Acericecis* are very different: its R5 vein is narrow, curved posteriorly on its distal half to join the costa at the wing apex, and no break is present at the junction of R5 and the costa. The female cerci of *Acericecis* are discrete, those of *Gliaspilota* fused.

Gliaspilota glutinosa (Osten Sacken), new combination

Cecidomyia glutinosa Osten Sacken 1862: 193; Felt 1909:

115 (*Caryomyia*); Gagné 1989: 211 (*Cecidomyia*); Gagné 2004: 277, as unplaced species of *Cecidomyiinae*.

Description.—**Gall** (Figs. 175–177): Occasional on both *Eucarya* and *Apocarya* sections, single or several on the underside of a leaflet; a discolored, mustard-yellow, irregularly ovate spot on the leaf lamina, 5–8 mm in diameter; presence apparent from top of leaf only by discoloration, but on bottom of leaf covered with a colorless mucilaginous substance.

Adult (female only): Head: Eye bridge about 5 facets long; facets circular, closely adjacent except slightly farther apart at midheight of head. Antenna with 10 flagellomeres, on one specimen the tenth nearly divided into two separate flagellomeres; third flagellomere as in Figs. 343–344. **Thorax:** Wing length 1.4–1.5 mm (n=3). Tarsal claws (Figs. 345) toothed or untoothed, sometimes one toothed and the other untoothed on same acropod. **Abdomen:** Sixth segment to cerci, Figs. 346–347.

Pupa: Unknown.

Larva: Third instar (Figs. 232–234, 349–350).—Yellow to orange. Spatula barely evident, only apical tooth showing, triangular. Dorsal papillae situated on long, flat lobes. Terminal segments as in Figs. **Second instar** (Fig. 348): Dorsal papillae not situated on lobes. Eighth and terminal abdominal segments as in Fig. 350.

Etymology.—The name *glutinosa* is an adjective from the Latin meaning sticky, with reference to the resinous substrate in which the larva lives.

Type material.—*Syntypes*: Three leaf spots characteristic of *G. glutinosa* damage, on leaflet fragments of *Carya* sp., Washington, DC, Osten Sacken, deposited in USNM; larva(e), same data, lost.

Biological notes.—Usually one, up to three free-living larvae can be seen in the liquid on each spot on the lower surface of leaflets. After full-

grown larvae drop to the ground, the tissue under the mucilage dries, and the leaf is left with an irregular, brown spot. In northeastern United States fresh galls can be found as early as mid-April. Larvae have all dropped to the soil by mid-June. In Florida I found fresh galls in September, so it is possible this species has more than one generation per year there.

Collections of galls.—(This species is much more common than apparent from the short list of collections; I did not always note every time I saw the characteristic damage, which, by mid-June except in Florida, the larvae have already vacated). **ARKANSAS:** Palestine (*ovata*). **FLORIDA:** Gainesville (*tomentosa*). **MARYLAND:** Beltsville, USDA Agricultural Research Center (*glabra*, *tomentosa*); Brighton (*tomentosa*); Calverton (*tomentosa*); Gaithersburg (*tomentosa*); Clarksburg (*tomentosa*). **MASSACHUSETTS:** Great Barrington (*cordiformis*, *ovata*). **MISSOURI:** Cadet (*Carya* sp.). **NEW YORK:** Albany (*Carya* sp.), New York (*Carya* sp.). **TEXAS:** Browntown (*illinoiensis*). **WASHINGTON, DC:** unspecified (*Carya* sp.). **WEST VIRGINIA:** Falling Waters (*cordiformis*); 6 mi NW Hedgesville (*ovata*).

Specimens of *C. glutinosa* examined.—**FLORIDA:** Gainesville, IX-21-2000 (larva). **MARYLAND:** Beltsville, USDA Agricultural Research Center, V-30-1993 (larvae), V-22-1994 (larvae), V-28-1994 (larvae; 3 ♀, em. IV-1995). **MISSOURI:** Cadet, VI-18-1883, B.D. Walsh (larva). **NEW YORK:** Albany, VI-1912, E.P. Felt (larva); New York, VI-20-1907, E.P. Felt (larva). **TEXAS:** Browntown, V-13-1982, M.B. Stoetzel (larva). **WEST VIRGINIA:** Falling Waters, VI-21-2004 (larvae); 6 mi NW Hedgesville, VII-26-2000 (larvae).

GENUS HARMANDIOLA KIEFFER

Harmandia Kieffer 1896: 5. Type species, *Cecidomyia tremulae* Winnertz, by original designation. Preocc. Rochebrune 1882.

Harmandiola Skuhrová 1997: 166, new name for *Harmandia* Kieffer; Gagné 2004: 163 (catalog).

Inclusion of *Cecidomyia nucicola* Osten Sacken enlarges the scope of this genus that heretofore comprised some gall-formers of poplars and chestnuts (Gagné & Payne 1992). In the key to Nearctic genera of Cecidomyiidae in Gagné (1981), *Harmandiola* runs to the first half of couplet

103 because the species known up to 1981 had toothed tarsal claws. Now that some species in the genus are known to have untoothed claws, the genus will also run to the first half of couplet 146 with *Paradiplosis*, except for the host indication. Wings of *Harmandiola* and *Paradiplosis* are different: the costal wing vein is broken at its junction with R_5 in *Harmandiola* but not in *Paradiplosis*.

Harmandiola nucicola (Osten Sacken), new combination

Cecidomyia caryae nucicola Osten Sacken 1870: 53, invalid polynomial; *caryaenucicola* Jarvis 1909: 84 (*Cecidomyia*).

Cecidomyia nucicola Osten Sacken 1878: 6; Felt 1918: 49 (*Caryomyia*); Gagné 1973: 868 (*Contarinia*).

Description.—**Gall** (Figs. 178–180): Rare, so far known only from *Eucarya* section; a single-chambered blister of the nut husk, up to 5 mm wide and 4 mm high, with same color and texture as husk; larval chamber ovoid, each with a single larva.

Adult (male only): Head: Eyes connate, about 6 facets long at vertex; facets mostly circular, closely adjacent except slightly farther apart at midheight of head. Occiput without dorsal protuberance. Antenna: scape cylindrical, shorter than wide, with 4 long, apicodorsal setae and 2 mesobasal trichoid setae; pedicel short-spherical, partially ringed with long setae ventrally and laterally; with 12 flagellomeres, the twelfth with short elongation to distal node; flagellomeres (Fig. 357) foreshortened, binodal but internodes and necks short, with 3 circumfila, 1 on basal node and 2 on distal node, loops of circumfila subequal in length, short, not attaining bases of next distal circumfilum, setulae on nodes sparse. Frons with 3–4 setae per side. Labrum with short setae on venter. Labellum separate, nearly hemispherical but blunt at apex, setulose, setose. Palpus 4-segmented. **Thorax:** Scutum with 4 longitudinal rows of setae. Scutellum with lateral group of setae on each side. Pleura hairless except for anepimeron with 9–10 setae. Wing 2.1 mm long; C broken at juncture with R_5 ; R_5 curved apically, joining C posterior to wing apex; Rs detectable only as bump on R_5 , about equidistant between arculus and R_1 . Legs about 1.5 times as long as wings; tarsal claws (Fig. 36) untoothed, curved beyond midlength; empodium as long as claws; pulvilli about 1/3 length of claws. **Male abdomen:**

First through seventh tergites entire, rectangular, about 5 times as wide as long; with 1 row of setae along posterior margin, another horizontal row on each side near midlength, with anterior pair of trichoid sensilla, and elsewhere covered with scales, the sixth and seventh tergites each with fewer scales and the seventh tergite with only 2 lateral setae; eighth tergite weakly sclerotized, short, anterior pair of trichoid sensilla the only vestiture. Sternites rectangular, about as wide as long, second through seventh with 1 or 2 horizontal rows of setae posteriorly, 3 groups of setae near midlength, these merging on seventh sternite, and 2 closely adjacent trichoid sensilla anteriorly; eighth sternite with several rows of setae posteriorly, bare anteriorly except for 2 widely separated trichoid sensilla. Genitalia (Figs. 352–355): cerci large, broad for greatest length, each abruptly narrowed near apex to evenly rounded lobe, the lobe setose peripherally and ventrolaterally; hypoproct slightly longer than cerci, linear, completely setulose, the apex bilobed with several apical and ventroapical setae, sides at midlength slightly ventrally curved, with bulbous ventral prominence before midlength; aedeagus elongate-linear, slightly longer than hypoproct; gonocoxite elongate-cylindrical; gonostylus long, evenly setose, the setae longer at base, setulose on basal third, carinate beyond.

Pupa: Unknown.

Larva: **Third instar:** Body cylindrical, anterior end tapered, posterior end broad. Head directed anteriorly, with apodemes longer than head capsule. Antenna about twice as long as wide. Spatula (Fig. 357) with anterior end deeply divided into two roughly equilateral triangular lobes, the lateral sides expanded and weakly erose, and with long posterior shaft. Integument on dorsum without sculpturing, on pleura with pointed verrucae anterior to spiracles, and on venter with horizontal rows of sharp spicules anterior to sternal papillae. Lateral papillae on each side of midline in two triplets, 2 of each group with short seta, the third of slightly larger diameter, without seta. Dorsal and pleural papillae with very short setae. Terminal segment (Fig. 356) mostly covered dorsally with pointed verrucae, with four pairs of papillae, one pair corniform, recurved, one pair situated between recurved pair short-corniform and situated on lobes, two pairs placed laterad, on lobes, with setae short, no longer than wide. **Second instar:** (not seen).

Type material.—*Syntypes:* Galls on nut husk, from *C. ovata*, Rhinebeck, NY, VIII-9–1869, Osten Sacken, in USNM; larva(e), same data as galls, lost.

Etymology.—The name *nucicola* is a Latin noun meaning nut inhabitant.

Affinities.—This species is tentatively placed in *Harmandiola* because its elongate hypoproct has a definite ventral projection near midlength and its aedeagus is long, parallel-sided, and blunt-tipped. Originally in *Cecidomyia* (Osten Sacken 1870), this species was later placed in *Contarinia* based on larval characters (Gagné 1973). The male, reared subsequently, does not fit in *Contarinia* because of its genitalia and the presence of three circumfilar loops on each flagellomere. The male differs from other species in *Harmandiola* by the regular instead of irregular-length circumfila loops of the male flagellomeres. Other known congeners have the middle circumfila shorter than the remaining two. Until now, *Harmandiola* contained 13 species (Gagné 2004); the 11 species with known hosts form galls on poplars and chestnuts (Gagné & Payne 1992). Larvae of this genus could pass for many other genera of Cecidomyiini, including *Contarinia* and *Macrodiplosis*, because of the makeup of the papillae of the terminal segment, particularly the large, corniform, recurved pair.

Biological notes.—The full-grown larva cuts a straight, cylindrical exit passage to the exterior of the nut husk and falls to the ground where it overwinters.

Collections of galls.—**GEORGIA:** Macon (*glabra*). **MARYLAND:** Silver Spring (*tomentosa*). **NEW YORK:** New York (*ovata*); Rhinebeck (*ovata*). **ONTARIO:** vic. Guelph (Jarvis 1909, *ovata*).

Specimens of *C. nucicola* examined.—**GEORGIA:** Macon, VI-2-1986, D. Ring (larvae). **MARYLAND:** Silver Spring, VII-2-1985, (larvae), VII-3-1992 (♂, em. V-1993). **NEW YORK:** New York, I-23-1884, E.B. Southwick (larva); Rhinebeck, VIII-9-1869, C. Osten Sacken (larva, excised from syntype gall).

GENUS PARALLELODIPLOYSIS RÜBSAAMEN

Parallelodiplosis Rübsamen 1910: 297. Type species, *Diplosis galliperda* Löw, monotypy; Gagné 2004: 217 (catalog).

This genus of 22 species is widely distributed but mainly Holarctic and includes inquilines in galls of insects from various orders (Gagné 2004).

Parallelodiplosis caryae (Felt)

Cecidomyia caryae Felt 1907: 45; Felt 1908: 411 (*Clinodiplosis*); Felt 1921: 168 (*Parallelodiplosis*).

Description.—**Adult:** **Head:** Eyes connate, 11–12 facets long at vertex; facets hexagonoid, all closely adjacent. Occiput with dorsal protuberance with 2 apical setae. Frons with 6–10 setae. Labellum ellipsoid, pointed apically, with several lateral setae. Palpus 4-segmented, with prominent palpiger. Male antennal flagellomeres binodal, distal node of each constricted at basal third; distalmost flagellomere with elongate, constricted terminus; 1 circumfilum present on basal node of each flagellomere, 2 on distal; loops of circumfila subequal in length, long, but not quite reaching next distal circumfilum. Female flagellomeres successively shorter from base to apex of antenna, the 6 first flagellomeres constricted and elongated between basal setae and basal band of circumfilum, remaining 6 flagellomeres evenly cylindrical, the last with elongate, constricted terminus; each flagellomere surrounded by two appressed circumfila connected by two longitudinal bands. **Thorax:** Wing unmarked, 2.3 to 2.9 mm long, R_5 strongly curved toward apex, joining C posterior to wing apex. Tarsal claws (Fig. 360) untoothed, bent beyond midlength; empodia reaching only about half distance to bend in claws. **Male abdomen:** Third through sixth tergites horizontally divided laterad between posterior and lateral setae, with anterior pair of trichoid sensilla, posterior setae continuous across sclerite. Seventh tergite similar in shape, but some specimens lack lateral setae and posterior row of setae discontinuous mesally; eighth tergite weakly pigmented, the only vestiture the anterior pair of trichoid sensilla. First through eighth sternites pigmented only on posterior two-thirds, anterior pair of papillae situated on basal, membranous third, setae present along posterior margin and covering midlength of sclerite. Genitalia (Figs. 361): cerci with posterior margin straight but slightly longer on lateral than mesal angle, with setae along posterior margin; hypoproct much longer than cerci, parallel-sided, nearly as wide as aedeagus, with 4–6 setae on posterior margin, and covered with long setulae on both dorsum and venter; aedeagus elongate, longer and slightly wider than hypoproct, distal margin convex; gonocoxite elongate-cylindrical,

splayed; gonostylus elongate-cylindrical, with setulae near base and covered beyond with minute carinae and widely scattered short setae. **Female abdomen:** First through sixth tergites as for male; seventh tergite undivided, longer than sixth; eighth tergite unpigmented with anterior pair of trichoid sensilla and posterior row of weak setae. First through sixth sternites as in male; seventh sternite fully pigmented, narrower and longer than sixth; eighth sternite unpigmented, with anterior pair of trichoid sensilla and scattered, short setae posteriorly. Ovipositor (Fig. 362) slightly protrusible, venter but not dorsum of ninth segment with setae, cerci elongate-ovoid, with pair of apical peglike setae and scattered setae elsewhere; hypoproct short, narrow, with 2 short, posterior setae.

Pupa: Head: Antennal base rounded apically, not conspicuously projecting anteriorly; cervical sclerite with two elongate setae; face without ventral projections, with 2 pairs of long-setose papillae, one on frons, one on labrum. Prothoracic spiracle elongate, pointed apically. Abdomen evenly covered with uniformly small, pointed spicules, none enlarged and spiniform.

Larva: **Third instar** (Fig. 48): Length 2.5–2.9 mm. Orange. Integument covered with mostly pointed verrucae. Antenna less than twice as long as wide. Spatula (Fig. 359) elongate, parallel-sided, with 2 rounded anterior teeth. Lateral thoracic papillae in 2 groups of 3 on each side of central line, 2 papillae in each group with tiny seta, the third without. Dorsal and pleural papillae with elongate setae. Terminal segment (Fig. 358) with 8 papillae as follows: 1 pair large-corniform, anteriorly recurved, pigmented; 1 pair with long setae, as long as dorsal setae of previous segment; 2 pairs with very short setae not surpassing width of socket but setae of outer pair slightly the larger. **Second instar** (not seen).

Type material.—**Holotype:** Male, taken on hickory, Albany, New York, VI–19–1906, Felt #331, deposited in New York State Museum, Albany.

Remarks.—The first published mention of this species was by Osten Sacken (1862). He wrote in his discussion under *C. holotricha* that he had found in some galls a pale orange larva with the anterior of the spatula ending in two triangular points. Larvae of *Caryomyia* species are white, so the orange color would describe a *Parallelodiplosis* larva (Fig. 48), and the forked spatula would pre-

clude it from belonging to *Lestodiplosis*. Felt (1907) based his initial description on a male caught on hickory, and his subsequent, fuller description (Felt 1921) on that male and also of a female caught at the same time as the male. He later obtained adults reared by a colleague from *Caryomyia inanis* galls (Felt 1908, 1921) and eventually succeeded in rearing some from at least *Caryomyia aggregata* galls (Felt 1921). The species has to date been associated with galls of ten species of *Caryomyia*. The larva and pupa are described here for the first time and the adults redescribed in full.

Affinities.—Of the described North American species in this genus, only one other, *Parallelodiplosis acernea* (Felt), has tarsal claws with a similar slight curve beyond midlength. Both species have generally similar male genitalia, but the hypoproct of *P. acernea* is definitely narrower with relation to the aedeagus than is that of *P. caryae*. The basal flagellomeres of the female antenna are regularly cylindrical in *P. acernea* rather than greatly constricted as in *P. caryae*. Larvae of the two species appear identical.

Interestingly, *P. acernea* is also an inquiline but in galls of *Pachypsylla* spp. (Hemiptera: Psyllidae) and possibly also *Celticecis* sp. nr. *spiniformis* (Cecidomyiidae) on hackberry, *Celtis occidentalis* L. (Moser 1965). First instars of *P. acernea* evidently bore into galls and enter cavities occupied by psyllid nymphs; nymphs of the psyllid always die after larvae of *P. acernea* reach them, possibly because of competition for food (Moser 1965).

Biological notes.—*Parallelodiplosis caryae* has now been found inside or reared from galls of 10 species of *Caryomyia* (see list of collections below). The very active, orange larvae can occasionally be seen in September and October inside *Caryomyia* galls (Fig. 48). On two occasions, once in Maryland, once in Massachusetts, I found third instars crawling on a leaf in the vicinity of *C. holotricha* galls. It is possible they had recently exited galls and were on their way to drop to the soil, although leaving the galls does not appear necessary because on several occasions I reared adults

in spring from *Caryomyia* galls kept through winter. When *P. caryae* larvae are found inside galls, the *Caryomyia* larvae are missing or dead and the surface of the larval chamber appears to be scraped, the chamber littered with the resulting particles. Access into the galls is evidently through a hole at the base or side of a gall, but I do not know precisely what makes the hole; it might have been caused by rot beneath a gall in which the gallmaker was already dead or possibly by some boring insect. A gall of *C. viscidolum* found in Piney, AR, had a small circular hole in its side. In another case, a predaceous *Lestodiplosis* larva also had presumably entered through a hole at the base of a gall of *C. tuberidolum* and was feeding on the *P. caryae* larva (Fig. 48).

Collections of galls and specimens of *P. caryae* examined.—ARKANSAS: Beulah (*tomentosa*), in gall of *C. tuberidolum*, IX-10-2004, larva; Chester (*texana*), in gall of *C. holotricha*, IX-9-2004, larva; Piney (*texana*), in gall of *C. hirtiglobus*, X-10-2004, larva. GEORGIA: Forsyth (*ovata*), in galls of *C. holotricha*, IX-22-2000, larvae. MARYLAND: Beltsville, USDA Agricultural Research Center (*tomentosa*), VIII-22-2000, larvae on leaf among galls of *C. holotricha*, and found in and reared from galls of *C. sanguinolenta* and *C. caryaecola*, X-2002, ♀, em. IV-2003; Clarksburg (*tomentosa*), in gall of *C. tuberidolum* (Fig. 48); Ellicott City (*tomentosa*), in gall of *C. purpurea*, IX-2-2000, larvae; Ridgely (*cordiformis*), in galls of *C. tubicola*, X-2-2000, ♂, ♀, pupae, em. IV-2001; and (*tomentosa*) in galls of *C. purpurea*, X-2-2000, larva. MASSACHUSETTS: Petersham (*ovata*), on leaf among galls of *C. holotricha*, IX-6-2000, larvae; Worcester (*Carya* sp.) ex galls of *C. inanis*, M.T. Thompson, 2 ♂, pupae. NEW YORK: Albany (*Carya* sp.), VI-19-1906, E.P. Felt, ♂ (holotype), ♀; Nassau (*Carya* sp.) ex galls of *C. holotricha*, VII-29-1906, E.P. Felt, larva; New York City (*Carya* sp.), ex galls of *C. aggregata* (reported as *C. persicoides* in Felt 1921: 169), E.P. Felt, 2 ♀. TEXAS: New Waverly (*tomentosa*), ex galls of *C. leviglobus*, X-6-2001, 2 ♂, em. IX-2002.

KEY TO HICKORY GALLS CAUSED BY CECIDOMYIIDAE

Caryomyia galls are best keyed still attached to their leaflets because their position on the lamina or leaf and any surrounding leaf exfoliation are useful characters. Some galls may need to be cut open in order to see their internal structure. For this key as well as in the illustrations, *Caryomyia* galls are oriented apex upwards without regard to which leaf surface they occur on.

Phylloxerids (Hemiptera: Phylloxeridae: *Phylloxera*) and eriophyids (Acarina: Eriophyidae) also form galls on hickories but their galls are distinct from those made by gall midges. *Phylloxera* galls (Figs. 181–182) contain aphidlike insects, often in large numbers. Mite galls (Figs. 1, 1a, 2) have no broadly open chamber but are instead made up of a series of tight wrinkles that enfold the many minuscule mites. Closed cecidomyiid galls on hickory will have one or more ovoid chambers, each containing a legless larva with a very small but definite head capsule.

1. Sticky leaf spot with exposed larva (Figs. 175–177) *Gliaspilota glutinosa*
- Simple or complex leaf or nut husk gall with enclosed larva 2
- 2(1). Gall a simple swelling of petiole, leaflet, or nut husk (Figs. 165–171, 178–180) 3
- Gall complex, on leaflet (Figs. 5–32, 36–164) 6
- 3(2). Hemispherical swelling of nut husk (Figs. 178–180) *Harmandiola nucicola*
- Swelling of petiole or leaflet (Figs. 165–171) 4
- 4(3). Circular, biconvex swelling of lamina (Figs. 33, 167–169) *Caryadiplosis biconvexa*
- Swelling of petiole or leaf vein (Figs. 165–166, 170–171) 5
- 5(4). Hard, elongate swelling of petiole or leaf vein (Figs. 165–166) *Caryadiplosis venicola*
- Soft, bubblelike swelling of lamina, known only from pecan (Figs. 170–171) *Contarinia bulliformis*
- 6(2). Recumbent, main axis parallel or nearly parallel to leaflet (Figs. 88–97, 172–173) 7
- Perpendicular to leaflet or only slightly leaning (Figs. 36, 145, 147) 12
- 7(6). Apex convex; exit apparent on opposite leaf surface; indehiscent (Figs. 29, 172–173) *Contarinia cucumata*
- Apex pointed; without apparent exit hole on opposite leaf surface; dehiscent (Figs. 88–97) 8
- 8(7). Abruptly narrowed before apex (Figs. 88–91) 9
- Gradually narrowed from base to apex (Figs. 92–97) 10
- 9(8). Surface rough, with sparse hair (Figs. 9a, 88–89) *Caryomyia eumaris*
- Surface smooth, hairless (Figs. 9, 90–91) *Caryomyia recurvata*
- 10(8). Hairless; base not bulbous, flattened against leaf surface (Figs. 96–97) *Caryomyia supina*
- Hairy; base bulbous (Figs. 92–95) 11
- 11(10). Hair long, crinkly (Figs. 92–93); on bitternut *Caryomyia spinulosa*
- Hair short, straight (Figs. 94–95); on *Eucarya* section *Caryomyia procumbens*
- 12(6). Surface hairy, the hair thick or sparse (Figs. 39, 51) 13
- Surface hairless except for possible tuft of sparse short hair at extreme apex (Figs. 41, 43) 37
- 13(12). With partial or complete false chamber above larval chamber (Figs. 99, 105) 14
- Without false chamber (Figs. 40, 50) 15
- 14(13). Depressed spheroid, densely covered with flat, decumbent hair; false chamber closed (Figs. 104–105) *Caryomyia tumida*
- Upstanding, sparsely covered with erect hair; false chamber open apically (Figs. 8, 98–99) *Caryomyia inanis*
- 15(13). Flattened, discoid, stellate (Figs. 32, 100–101) *Caryomyia asteris*
- Elongate or spheroidal, not stellate (Figs. 39, 64) 16
- 16(15). Wall almost uniformly thin, brittle, gall of same shape as larval chamber (Figs. 40, 65) 17
- Wall thick, soft or woody, extraneous to shape of ovoid larval chamber (Figs. 132, 159) 23
- 17(16). Elongate-conical, gradually narrowed from base to apex; hair as long as gall diameter; dehiscing in spring (Figs. 39–40) *Caryomyia albipilosa*
- Spheroidal; hair not half as long as gall diameter; dehiscing in summer/fall (Figs. 49, 53) 18
- 18(17). Apex with dimple; larval chamber with intrusion of hair from apex (Figs. 23, 112–115) *Caryomyia thompsoni*
- Apex without dimple; larval chamber without intrusion of hair from apex (Figs. 50, 54) 19
- 19(18). Hair thick, obscuring surface (Figs. 49–50) 20

	Hair sparse, not obscuring surface (Figs. 51–52)	21
20(19).	Tuft of hair at apex thicker and longer than remaining hair, tuft covering circular, apical, thin areola (Figs. 49–50)	<i>Caryomyia hirtidolum</i>
	Hair uniformly distributed; surface texture uniform (Figs. 53–54)	<i>Caryomyia hirtiglobus</i>
21(19).	Base with deep, circular central impression; apex with circular, thin areola surrounding nipple; on bitternut (Figs. 51–52)	<i>Caryomyia cilidolum</i>
	Base conical at center; apical texture uniform except for nipple; on <i>Eucarya</i> section (Figs. 64–67)	22
22(21).	With prominent apical nipple; hair brown, stiff, erect (Figs. 64–65)	<i>Caryomyia spiniglobus</i>
	With slight apical nipple; hair white, soft, decumbent (Figs. 66–67)	<i>Caryomyia deflexipili</i>
23(16).	Larval chamber with conspicuous tuft of hair intruding apically (Figs. 116–117)	<i>Caryomyia holotricha</i>
	Larval chamber without intrusion of hair (Figs. 124–125, 132–133)	24
24(23).	Obconic, apex flattened; hair appreciably thicker and darker at apex than elsewhere (Figs. 123–125)	<i>Caryomyia turbinata</i>
	Spheroidal or widest near base or middle; hair uniformly distributed throughout or thicker at base (Figs. 132–133, 137–140)	25
25(24).	On upper leaf surface; bulbous base smooth and hairy, conical apex bumpy and nearly hairless (Figs. 132–133)	<i>Caryomyia turbanella</i>
	On lower leaf surface; not conspicuously bumpy apically, uniformly hairy throughout (Figs. 137–140, 145–150)	26
26(25).	Surface smooth, easily visible through sparse hair (Figs. 137, 139)	27
	Surface rough and/or covered with resinous dots, the hair usually thick (Figs. 145, 147, 152)	28
27(26).	Spheroidal at base, becoming conical (Figs. 137–138)	<i>Caryomyia conoidea</i>
	Discoid at base, narrowed abruptly beyond (Figs. 139–140)	<i>Caryomyia marginata</i>
28(26).	Narrowed abruptly from large base; apex digitate (Figs. 145, 147)	29
	Spheroidal or conical and narrowed gradually; apex not digitate (Figs. 154–158)	32
29(28).	Base variously lobed (Figs. 145–146)	<i>Caryomyia inclinata</i>
	Base evenly spherical (Figs. 147, 149, 152)	30
30(29).	On lamina; some hair stiff and as long as gall diameter (Figs. 14, 152–153)	<i>Caryomyia echinata</i>
	On or adjacent to veins; hair bowed, less than half gall diameter (Figs. 147, 149)	31
31(30).	Surface with dark, resinous dots; on <i>Eucarya</i> section (Figs. 149–150)	<i>Caryomyia cucurbitata</i>
	Surface without resinous dots; on bitternut (Figs. 147–148)	<i>Caryomyia ansericollum</i>
32(28).	Surface visible through hair (Figs. 154, 158)	33
	Surface not visible through hair (Figs. 121, 156)	34
33(32).	Base with central hemispherical connection to leaf; surface smooth, hair extensive (Figs. 158–159)	<i>Caryomyia antennata</i>
	Base with circular central impression; surface rough, covered with resinous dots, hair sparse (Figs. 154–155)	<i>Caryomyia guttata</i>
34(32).	On lamina; base with deep, circular, central impression; larval chamber usually purple (Figs. 15, 121–122)	<i>Caryomyia purpurea</i>
	On or closely adjacent to leaf vein; base without central depression; larval chamber green or brown (Figs. 126–129, 156–157, 160–161)	35
35(34).	Unevenly spheroidal, usually found closely compressed into groups; larval chamber irregularly ovoid (Figs. 21a–21b, 156–157)	<i>Caryomyia aggregata</i>
	Spherical to conical, always discrete; larval chamber ovoid	36
36(35).	Spherical, woody; larval chamber at center of gall (Figs. 21, 160–161)	<i>Caryomyia spherica</i>
	Spheroidal or conical, soft, the top portion eventually shrinking somewhat; larval chamber at base of gall (Figs. 17, 126–129)	<i>Caryomyia persicooides</i>
37(12).	Surface sticky to touch	38
	Surface not sticky	44
38(37).	Sheathed at base by conspicuous leaf exfoliation (Figs. 83, 107)	39
	Not sheathed at base by conspicuous leaf exfoliation (Figs. 41, 55)	40
39(38).	Spherical, rubbery; larval chamber surrounded laterally and above by large, false chamber (Figs. 5, 106–107)	<i>Caryomyia lenta</i>
	Short-cylindrical, hard; without false chamber (Figs. 30, 82–83)	<i>Caryomyia melicrustum</i>
40(42).	With apical nipple surrounded by large areola (Figs. 43, 47)	41
	Surface uniform or apex concave or with simple umbo (Figs. 41, 55, 78)	42

- 41(40). Surface bumpy, conspicuously covered with resin glands; usually on under surface of leaflet (Figs. 46–48) *Caryomyia tuberidolum*
 Surface smooth, with sparse resin glands; on upper surface of leaflet (Figs. 25, 43–45) *Caryomyia viscidolum*
- 42(40). Surface bumpy; base with deep, circular, central impression (Figs. 118–119) *Caryomyia tuberculata*
 Surface smooth except for minute resin glands; base conical (Figs. 55–56, 78–80) 43
- 43(42). Spheroidal, apex convex; surface smooth, hard, brittle (Figs. 18, 20–20a, 55–58) *Caryomyia caryae*
 Short-cylindrical, apex concave; corona surrounding concavity soft at first, later contracting and forming rough, brown crust (Figs. 16a, 78–81) *Caryomyia flaticrustum*
- 44(37). With false chamber above larval chamber (Figs. 102–103, 108–111) 45
 Without false chamber 47
- 45(44). Nearly three times as long as wide, sheathed at base by leaf exfoliation; false chamber open at apex (Figs. 7, 108–109) *Caryomyia caminata*
 No more than twice as long as wide, without leaf extension surrounding base; false chamber closed (Figs. 102–103, 110–111) 46
- 46(45). Texture rubbery; about as wide as long; with umbo at apex (Figs. 5a, 102–103) *Caryomyia inflata*
 Woody; about twice as high as wide; without umbo at apex (Figs. 110–111) *Caryomyia ovalis*
- 47(44). Elongate-cylindrical, usually at least twice as long as wide (Figs. 37, 41, 72, 75) 48
 Spheroidal or conical, about as long as wide (Figs. 59, 62) 51
- 48(47). Base with shallowly concave, circular, central impression, not set into leaf socket (Figs. 37–38, 41–42) 49
 Base conical or deeply recessed, set into surrounding leaf socket (Figs. 72–77) 50
- 49(48). Surface minutely striate; apex pointed (Figs. 36–38) *Caryomyia striolata*
 Surface smooth; apex blunt, with umbo at center (Figs. 28, 41–42) *Caryomyia urnula*
- 50(48). Evenly cylindrical; base conical (Figs. 26, 74–77) *Caryomyia tubicola*
 Tapered from base to pointed apex; base deeply recessed (Figs. 27, 72–73) *Caryomyia subulata*
- 51(47). Wall uniformly thin, of same shape as larval chamber (Figs. 60, 63) 52
 Wall thick, extraneous to shape of larval chamber (Figs. 135, 164) 55
- 52(51). Spherical, with umbo or nipple at apex (Figs. 62, 68) 53
 Spheroidal, narrowed beyond midlength (Figs. 59, 70) 54
- 53(52). Surface minutely striate, green; with prominent nipple at apex (Figs. 19, 62–63) *Caryomyia leviglobus*
 Surface smooth, glaucous; with small umbo at apex (Figs. 68–69) *Caryomyia glauciglobus*
- 54(52). Abruptly narrowed beyond midlength to blunt apex; on lamina (Figs. 59–61) *Caryomyia shmoor*
 Gradually narrowed beyond midlength to pointed apex; on vein (Figs. 12–13, 70–71) *Caryomyia caryaecola*
- 55(52). Short-cylindrical, apex flat to concave; base sheathed by leaf exfoliation (Figs. 84–87) 56
 Conical to spheroidal; base not sheathed by leaf exfoliation (Figs. 135, 163) 57
- 56(55). Surface minutely striate laterally, rugose apically (Figs. 31, 84–85) *Caryomyia striolacrustum*
 Surface smooth (Figs. 86–87) *Caryomyia levicrustum*
- 57(55). Conical (Figs. 130, 134, 141, 143) 58
 Spheroidal (Figs. 144, 163) 61
- 58(57). Surface covered with conspicuous bumps (Figs. 130–131) *Caryomyia glebosa*
 Surface smooth except for longitudinal furrows (Figs. 134, 141) 59
- 59(58). Base curved upwards, apex set in resulting concavity (Figs. 141–142) *Caryomyia arcuata*
 Base parallel to leaf (Figs. 134, 143) 60
- 60(59). Base expanded horizontally, usually stellate; cone elongate-attenuate (Figs. 11a, 143) *Caryomyia stellata*
 Broadly conical (Figs. 10, 134–136) *Caryomyia sanguinolenta*
- 61(57). Spheroidal, attached to vein; multi-chambered (Figs. 162–164) *Caryomyia cynipsea*
 Depressed-spheroidal, on lamina; single chambered (Figs. 16, 144) *Caryomyia biretta*

KEY TO MATURE LARVAE OF CECIDOMYIIDAE ON HICKORIES

Mature (third instar) cecidomyiid larvae can usually be characterized by the presence of a spatula, a sclerotized dermal structure on the venter of the prothorax (Fig. 269). This structure usually serves to separate a third instar from a second instar, which usually has none. There are, however, exceptions, including *Caryomyia*, in which the second instar has secondarily developed a spatula. A couplet is added here that will separate those two instars of *Caryomyia*. The key to galls is still the best way to key *Caryomyia* spp. because galls are distinctive, unlike larvae of some species that can only be keyed to group. This key to larvae nonetheless points out those differences that do occur among species of *Caryomyia* and serves as validation when used in combination with the gall key.

1. Terminal abdominal segment with 6–8 papillae each bearing a seta or short, thick corniform structure (Figs. 334, 348) 2
2. Terminal abdominal segment with 8 flat or domed papillae (Fig. 271), none with seta or corniform structure; genus *Caryomyia* 10
- 2(1). Dorsum with conspicuous pseudopods (Figs. 232, 350) *Gliaspilota glutinosa*
- 2(2). Dorsum without pseudopods 3
- 3(2). Antennae more than 3 times as long as wide; venter with pseudopods; anus dorsal *Lestodiplosis* spp., not keyed further, see p. 9
- 3(2). Antennae no more than twice as long as wide (Fig. 228); venter without pseudopods; anus ventral (Fig. 270) 4
- 4(3). Terminal abdominal segment with papillae all similarly setose (as in Fig. 348) *Dasineura* sp., not keyed further, see p. 3
- 4(3). Terminal abdominal segment with dissimilar papillae, at least one pair corniform (Figs. 334, 358) 5
- 5(4). Terminal abdominal segment with 1 pair of papillae with long setae, 2 pairs with short setae, and one pair of large, recurved, corniform papillae (Fig. 358) *Parallelodiplosis caryaee*
- 5(4). Terminal abdominal segment with 3 pairs of short, setiform papillae and 1 pair of corniform papillae (Figs. 334, 356) 6
- 6(5). Terminal segment completely smooth, without verrucae, the 3 pairs of setiform papillae not situated on lobes (Fig. 334) *Caryadiplosis venicola*
- 6(5). Terminal segment with some verrucae, the 3 pairs of setiform papillae situated on lobes (Figs. 336, 356) 7
- 7(6). Spatula with bilaterally symmetrical teeth (Figs. 337, 339) 8
- 7(6). Spatula with serrated, laterally lobed teeth (Figs. 342, 357) 9
- 8(7). Spatula teeth triangular (Fig. 339); terminal segment with verrucae between corniform papillae (Fig. 338) *Contarinia cucumata*
- 8(7). Spatula teeth rounded (Fig. 337); terminal segment without verrucae between corniform papillae (Fig. 336) *Caryadiplosis biconvexa*
- 9(7). Setae of setiform terminal papillae mostly conspicuous, two pairs appreciably longer than third pair (Fig. 341) *Contarinia bulliformis*
- 9(7). Setae of setiform terminal papillae barely longer than sockets, all of approximately same length (Fig. 356) *Harmandiola nucicola*
- 10(1). Collar segment with group of conspicuously enlarged spicules on each side (Fig. 273); tooth of spatula acutely triangular, usually half as long as rectangular shaft (Fig. 273) *Caryomyia*, second instars; not keyed further
- 10(1). Collar segment either without spicules (Fig. 269) or spicules uniform in size (Fig. 228); anterior tooth of spatula, if acutely triangular, usually much less than one third as long as spatula (Figs. 316–327); *Caryomyia*, third instars 11
- 11(10). Spatula with 2 separate teeth (Figs. 274–275, 282–285) or tooth parallel-sided and notched at apex, (Figs. 286–289, 291) 12
- 11(10). Spatula with single triangular tooth (Figs. 276–281, 290) 25
- 12(11). Spatula teeth separated to shaft, occasionally with denticles between (Figs. 274–275, 282–285) 13
- 12(11). Spatula tooth more or less parallel-sided with notch at apex (Figs. 286–289, 291) 17

- 13(12). Spatula teeth equilateral, the space between with one or more denticles (Figs. 274–275); abdomen with extensive smooth areas (Figs. 215–217) *C. albipilosa, C. striolata*
 Spatula teeth appreciably longer than wide, the space between evenly concave (Figs. 282–285); abdomen completely covered with verrucae or spicules (Figs. 218–219) 14
- 14(13). Head directed anteriorly (as in Fig. 224); dorsal and pleural papillae of abdomen without setae *C. subula*
 Head directed ventrally (Fig. 219); dorsal and pleural papillae of abdomen with setae 15
- 15(14). Dorsal papillae of prothorax without setae or, if setae appear to be present, no longer than width of socket *C. caryae*
 Dorsal papillae of prothorax with setae 16
- 16(15). Spatula teeth separated from one another by distance greater than their length (Fig. 283); pleural papillae of prothorax with setae *C. hirtiglobus*
 Spatula teeth separated from one another by distance shorter than their length (Fig. 284); pleural papillae of prothorax without setae *C. shmoor*
- 17(12). Terminal segment tapering, pointed, as long as or longer than eighth (Fig. 229); dorsal and lateral papillae situated on prominent bases Fig. 228) 18
 Terminal segment convex, not pointed, shorter than eighth (Fig. 220); dorsal papillae not situated on prominent bases (as in Fig. 216) 20
- 18(17). Terminal segment approximately as long as eighth (as in Fig. 230); terminal setae situated posterolaterally (Fig. 271) *C. asteris, C. inanis*
 Terminal segment at least 1 1/2 times as long as eighth segment (Fig. 226–227); terminal setae situated ventrally (Fig. 229) 19
- 19(17). Spatula shaft no wider than tooth (Fig. 298) *C. deflexipili*
 Spatula shaft much wider than tooth (Fig. 299) *C. glauciglobus*
- 20(17). Abdominal segments 1–7 with 6 dorsal papillae 21
 Abdominal segments 1–7 with 4 dorsal papillae 24
- 21(20). Spatula tooth minutely serrate at apex (Fig. 297) *C. caminata*
 Spatula tooth strongly notched at apex (Fig. 286, 311) 22
- 22(21). Body completely covered with verrucae *C. caryaecola*
 Body with extensive smooth areas 23
- 23(22). Abdominal segment 8 with extensive verrucae between spiracles *C. cynipsea*
 Abdominal segment 8 entirely smooth between spiracles *C. inflata, C. tumida*
- 24(20). Spatula cruciate, the shaft very broad anteriorly, tooth conspicuously narrowed from base to notched apex Figs. 287–289) *C. flaticrustum, C. melicrustum, C. striolacrustum*
 Spatula, if broad at anterior end of shaft, with more or less parallel-sided tooth (Figs. 291, 306)
C. arcuata, C. biretta, C. conoidea, C. cucurbitata, C. echinata, C. eumaris, C. glebosa, C. marginata, C. persicoidea, C. procumbens, C. purpurea, C. recurvata, C. sanguinolenta, C. spinulosa, C. stellata, C. supina, C. turbinata, C. turbinella
- 25(11). Head directed ventrally, prothorax hooded above head capsule (Figs. 230–231); dorsal and pleural papillae on prominent, raised bases 26
 Head directed anteriorly; dorsal and pleural papillae not on prominent, raised bases 30
- 26(25). Papillae, except on terminal segment, all with setae (as in Fig. 281) *C. leviglobus, C. spiniglobus*
 Papillae without setae (as in Fig. 279) 27
- 27(26). Terminal abdominal segment acute; spatula tooth about 1/2 length of shaft (Fig. 279)
C. viscidolum
 Terminal abdominal segment rounded (Fig. 230); spatula tooth 1/3 or less length of shaft (Fig. 280) 28
- 28(27). Anterior end of spatula shaft narrow, rounded (Fig. 277) *C. cilidolum*
 Anterior end of spatula wide, angular (Figs. 280) 29
- 29(28). Spatula shaft twice as broad anteriorly and posteriorly than at midlength (Fig. 280) *C. tuberidolum*
 Spatula shaft only slightly broader anteriorly and posteriorly than at midlength (Fig. 278) *C. hirtidolum*
- 30(25). Dorsal and pleural papillae with short setae *C. sphaerica*
 Dorsal and pleural papillae without setae 31
- 31(30). Body completely covered with verrucae (as in Figs. 221–222) 32
 Body partly smooth, at least at midlength of ventral abdominal segments (as in Figs. 215–217) 33
- 32(31). Spatula tooth about 1/3 length of shaft (Fig. 316) *C. thompsoni*
 Spatula tooth about 1/5 length of shaft; 2, occasionally 3, lateral papillae on each side of spatula (Fig. 276) *C. urnula*

33(31). Abdominal segments without posterior spicules on venter	34
Abdominal segments with posterior spicules on venter	36
34(33). Abdominal segments with verrucae at midlength on dorsum	<i>C. tubicola</i>
Abdominal segments with verrucae only laterally on dorsum	<i>C. levicrustum</i>
36(33). Abdominal first through seventh segments with 4 dorsal papillae .	<i>C. aggregata</i> , <i>C. ansericollum</i> , <i>C. guttata</i>
Abdominal first through seventh segments with 6 dorsal papillae	<i>C. antennata</i> , <i>C. holotricha</i> , <i>C. inclinata</i> , <i>C. lenta</i> , <i>C. ovalis</i> , <i>C. tuberculata</i>

ACKNOWLEDGMENTS

I thank the many people who helped advance this long project, first of all Sally Gagné, whose favorite gall midges these are, for her interest and constant support. Lucrecia Rodriguez of the Systematic Entomology Laboratory (SEL) deserves special mention for her multivariated computer assistance and making plates out of the color and SEM photographs, all with effusive good humor. Diana Marques expertly made plates out of the line drawings. I acknowledge also Robert W. Carlson, SEL, for his help with computer programs and equipment. Nit Malikul continued her much appreciated, painstaking task of rendering permanent slide mounts, so indispensable for gall midge work. Scott D. Whittaker, SEM Lab Manager, Smithsonian Institution, patiently assisted my sessions with the SEM. For their interest and hospitality, leading me to good collection sites, and in some cases, making additional collections on their own, I am grateful to: Wayne Brewer, University of Alabama, Auburn, AL; Richard L. Brown, University of Mississippi, Starkville, MS; Denis and Barbara Gagné, Amston, CT and Murrells Inlet, SC; Kenneth L. Hibbard, Florida Department of Agriculture and Consumer Services, Ft. Pierce, FL; Tim L. McCabe, New York State Museum, Albany, NY; Jerry and Rose Payne, Lizella, GA; Gary J. Steck, Florida State Collection of Arthropods, Gainesville, FL; and Manya B. Stoetzel, Long Beach, MD, whom I also thank for Figs. 170–171. Larry Löf, Director of the Gorgas Science Founda-

tion, Inc., Brownsville, Texas, graciously allowed me to accompany a group visiting the Foundation's field station, Rancho del Cielo, in the Sierra Madre Oriental, SW of Victoria, Tamaulipas, Mexico, to search for *Caryomyia* there. L.J. Grauke, USDA Pecan Breeding and Genetics Laboratory, College Station, Texas, kindly gave advice and information concerning hickories. Kevin Tunison, USDA National Arboretum, Washington, DC, granted me permission to collect in the National Arboretum, Washington, DC. Hymenopterist colleagues in the SEL, Matthew Buffington, Michael W. Gates, Eric E. Grissell, and Terry P. Nuhn, enthusiastically received and identified reared parasitoid Hymenoptera. Ronald A. Ochoa of the same Laboratory kindly identified the mite galls in Figs. 1–2. Allen L. Norrbom, Lead Scientist, Diptera Unit, SEL, was unstintingly supportive of my work. I thank John Updike for kindly granting me permission to use as epigraph part of his poem *Condo Moon* that evokes so beautifully the history of life, and the Ohio Academy of Science for permission to republish the two fine plates from Wells 1916 that serve here as an additional practical aid for identifying the hickory gall midges. I am grateful also to both the in-house and journal reviewers for their careful reading, corrections, and suggestions: Michael W. Gates and Allen L. Norrbom, both of SEL; Netta Dorchin, Bucknell University, Lewisburg, Pennsylvania; Keith M. Harris, Ripley, United Kingdom; and Peter Kolesik, University of Adelaide, South Australia, Australia.

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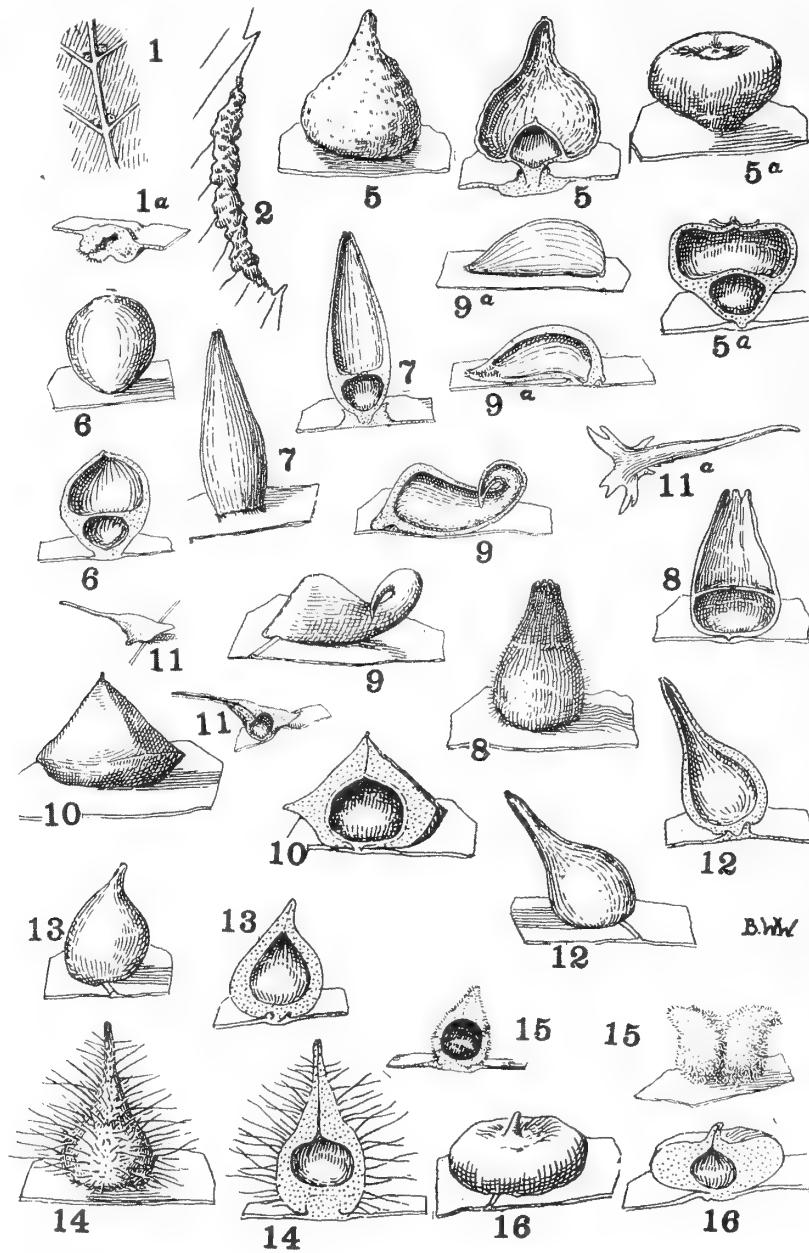
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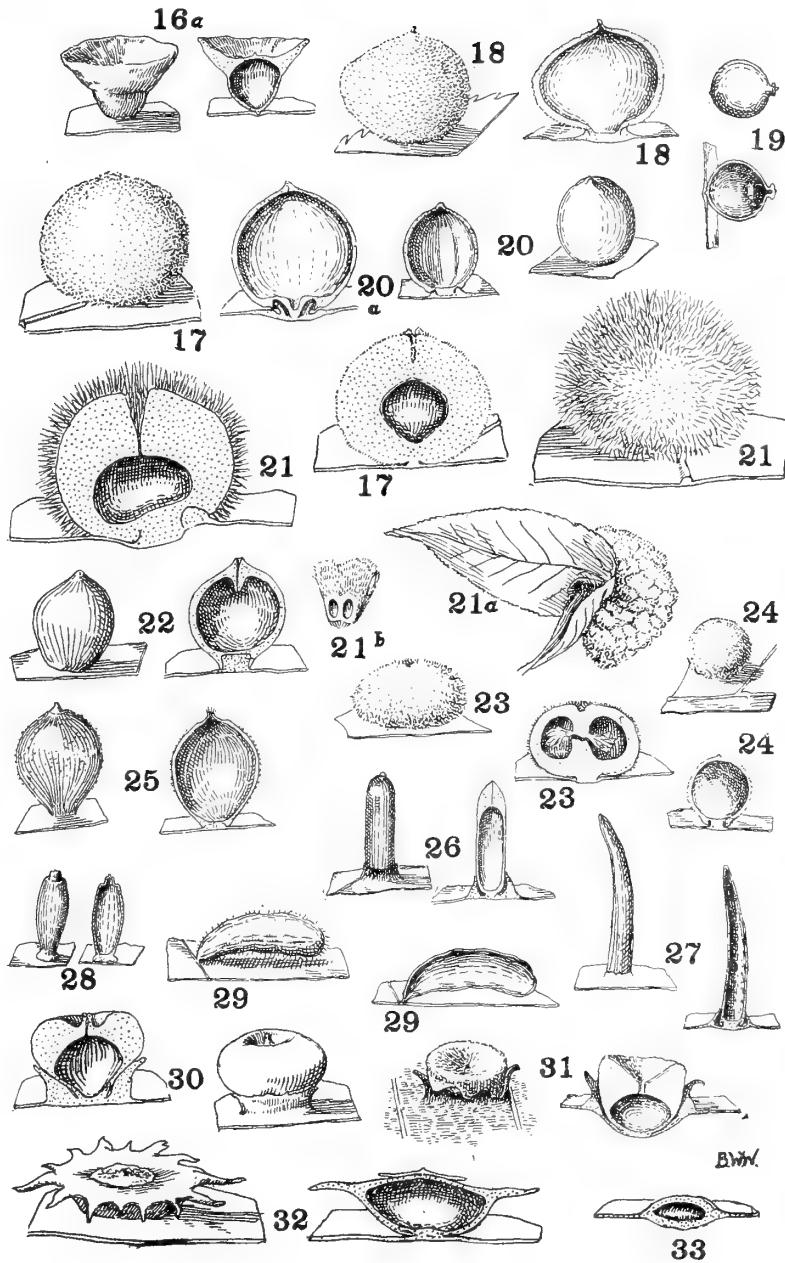


Bertram W. Wells.

Figs. 1-16. Plate I of Wells, 1916, reproduced through the courtesy of The Ohio Academy of Science. Galls of hickory. Figs. 1-2, Eriophyidae mite galls. 1, 1a, *Eriophyes* sp. 2, *Aceria caryae* (Keifer). Figs. 3-4, Nonexistent: these numbers referred in Wells's text to species for which he had no figures. Figs. 5-16, Cecidomyiidae, *Caryomyia* spp. 5, *C. lenta*. 5a, *C. inflata*. 6, possibly *C. ovalis* or young gall of *C. inflata*. 7, *C. caminata*. 8, *C. inanis*. 9, *C. recurvata*. 9a, *C. eumaris*. 10, *C. sanguinolenta*. 11, Possibly *C. stellata*. 11a, *C. stellata*. 12 & 13, *C. caryaecola*. 14, *C. echinata*. 15, *C. purpurea*. 16, *C. biretta*.

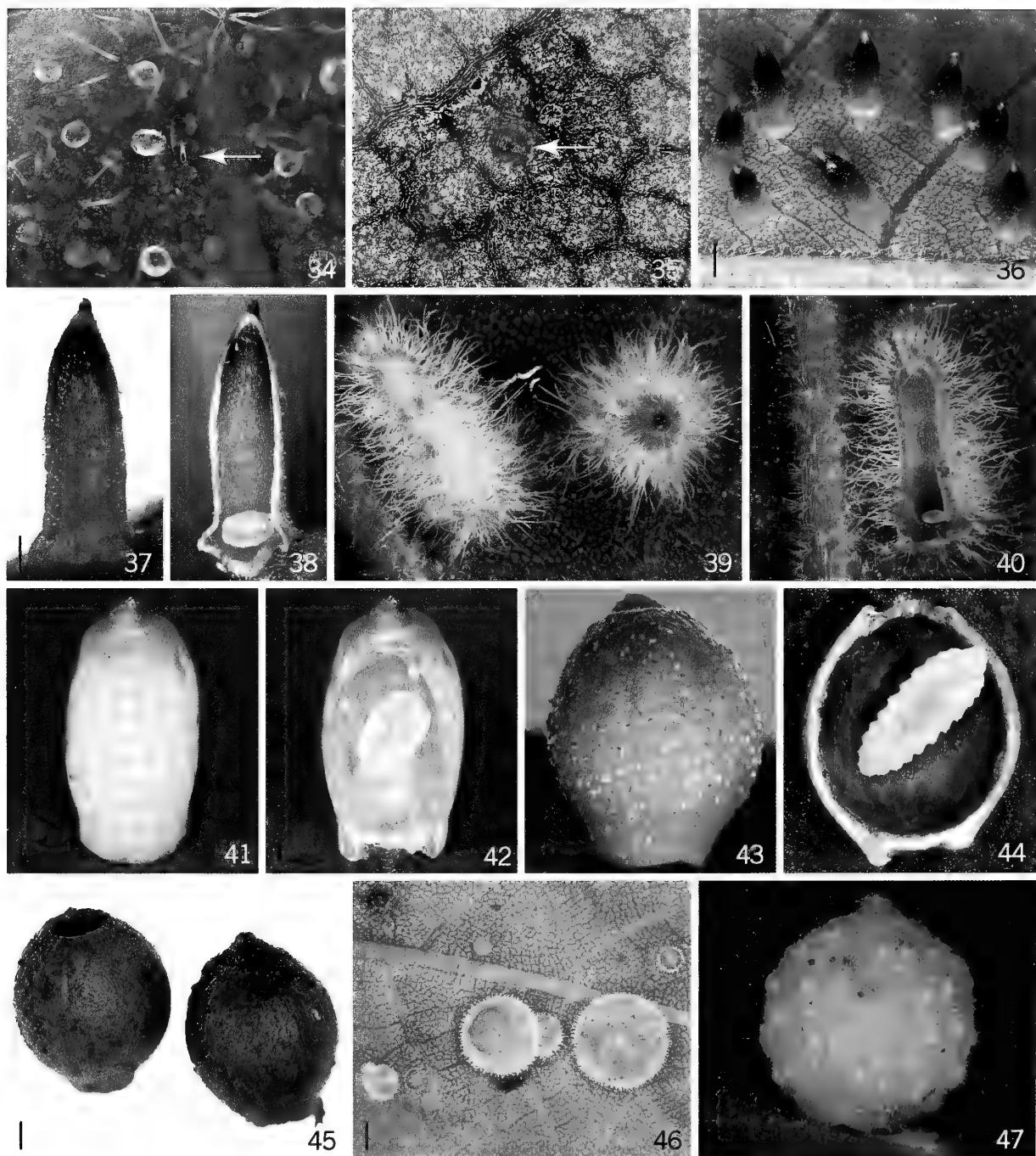
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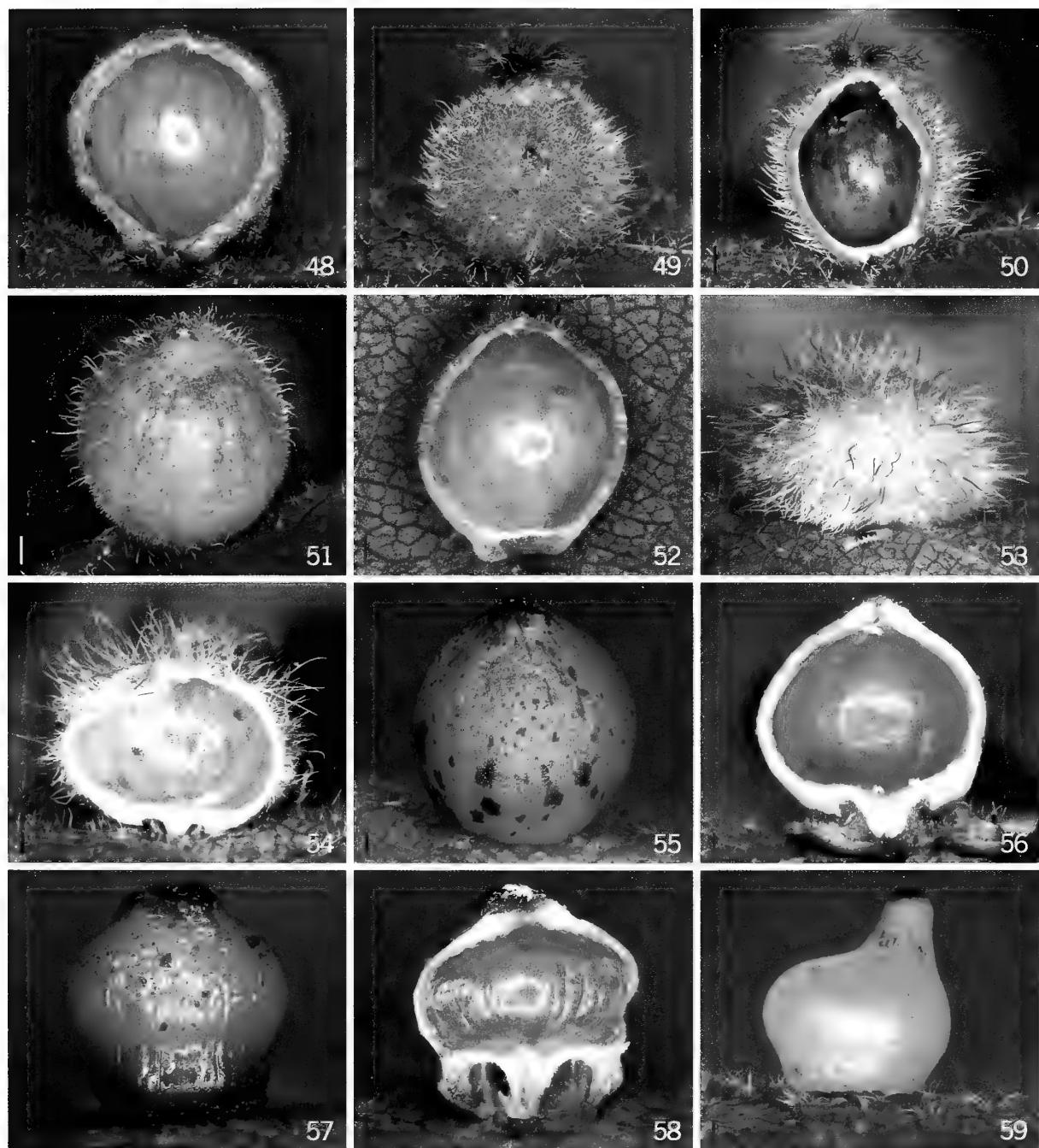


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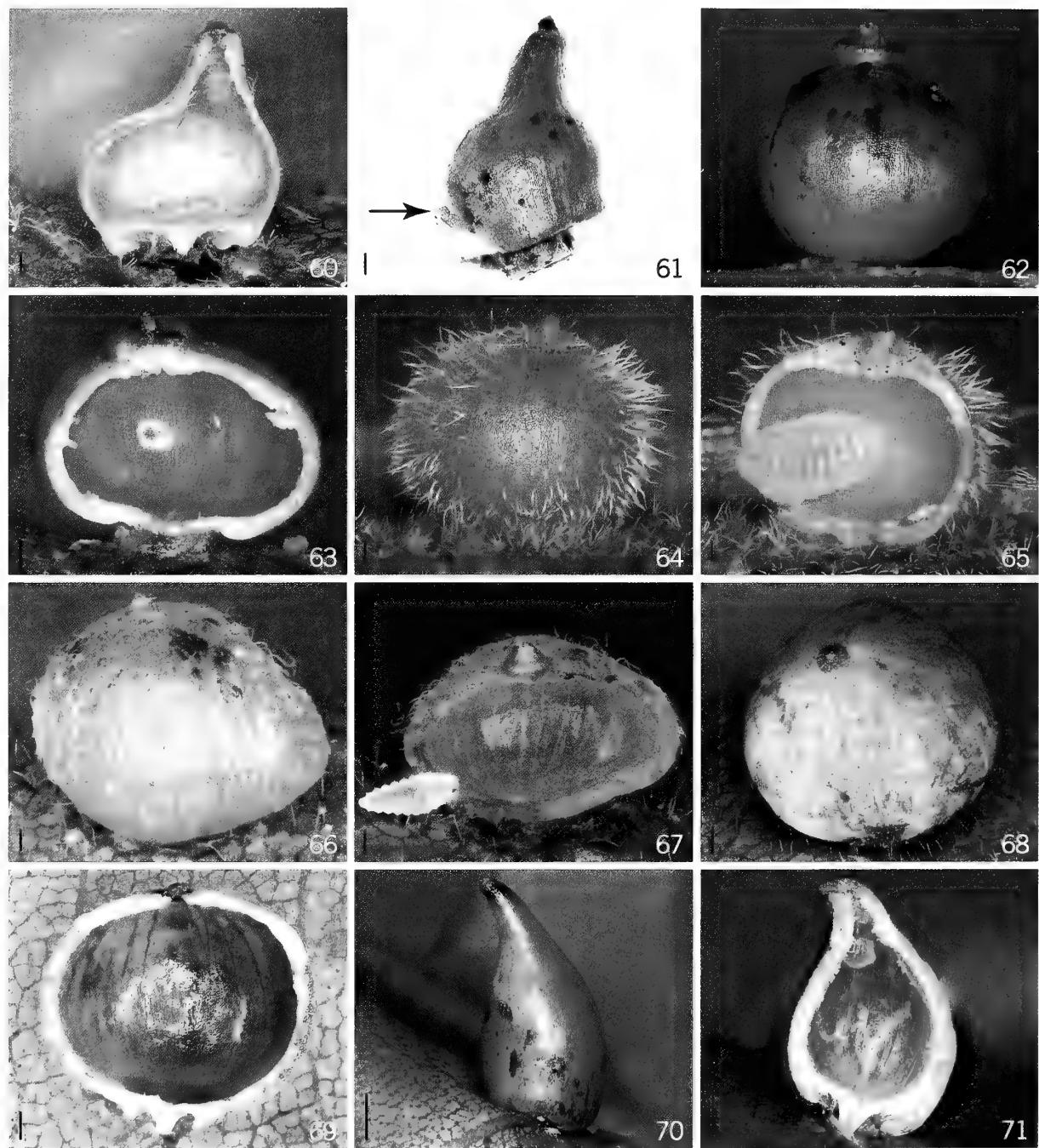
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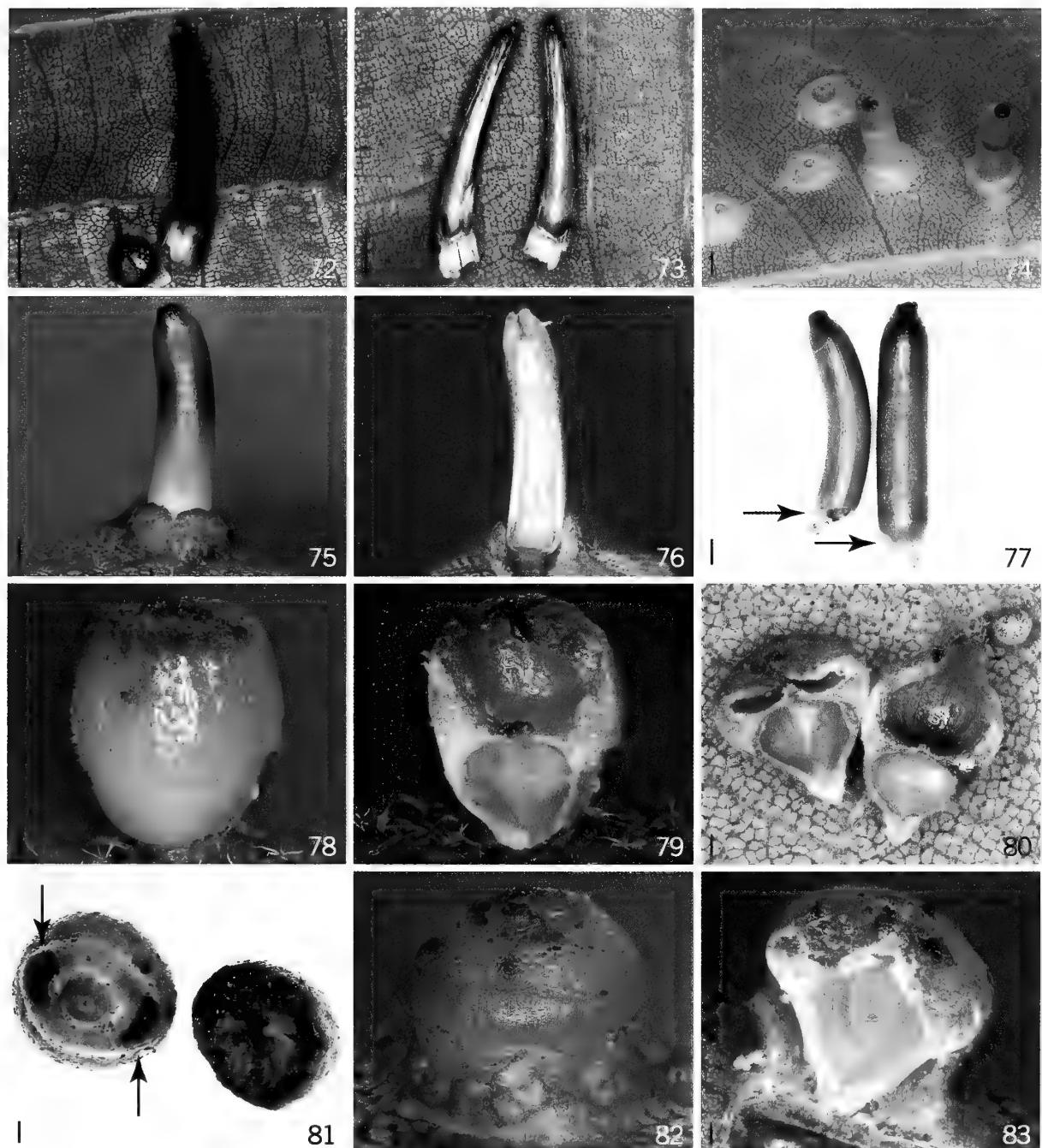
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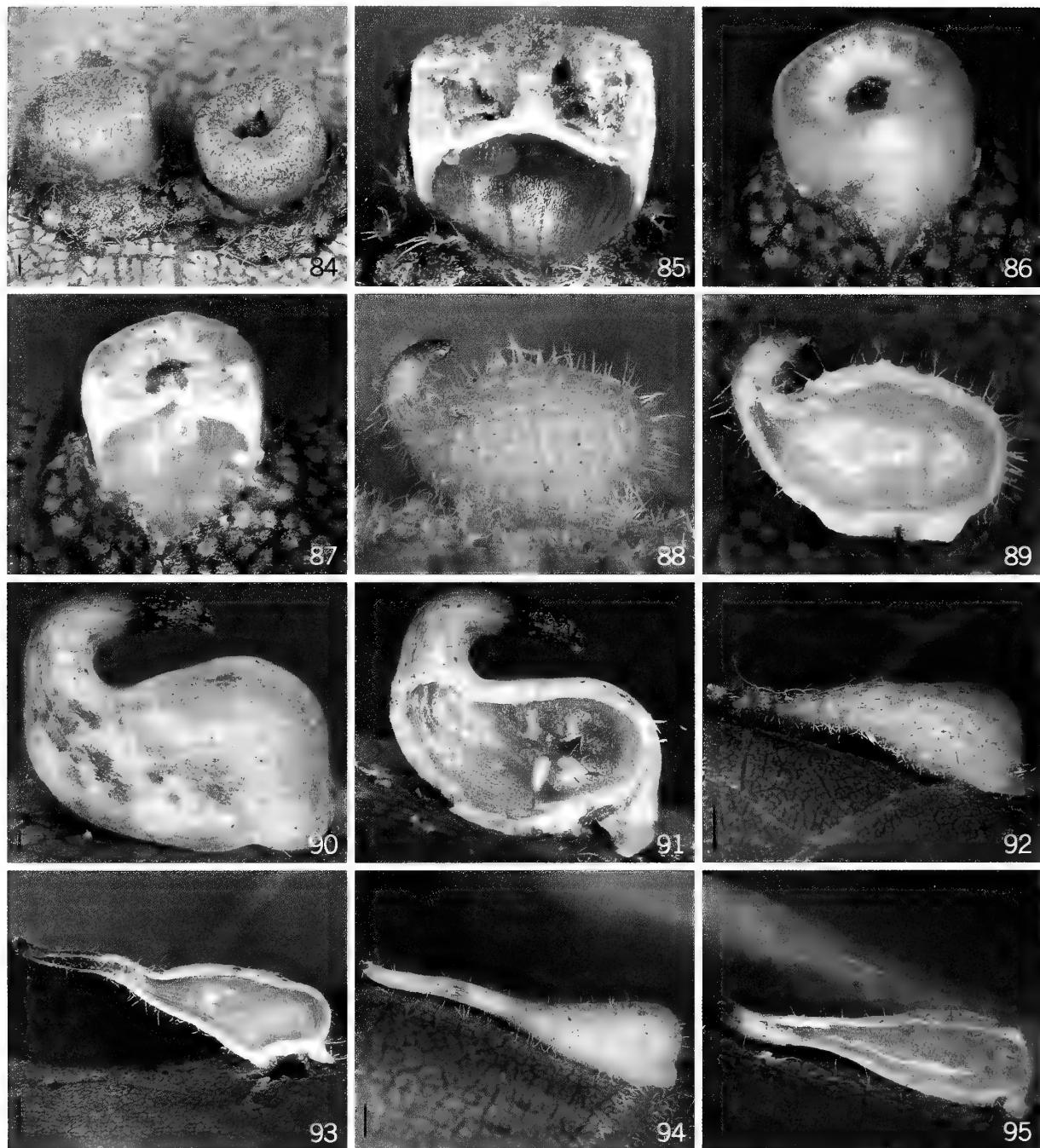
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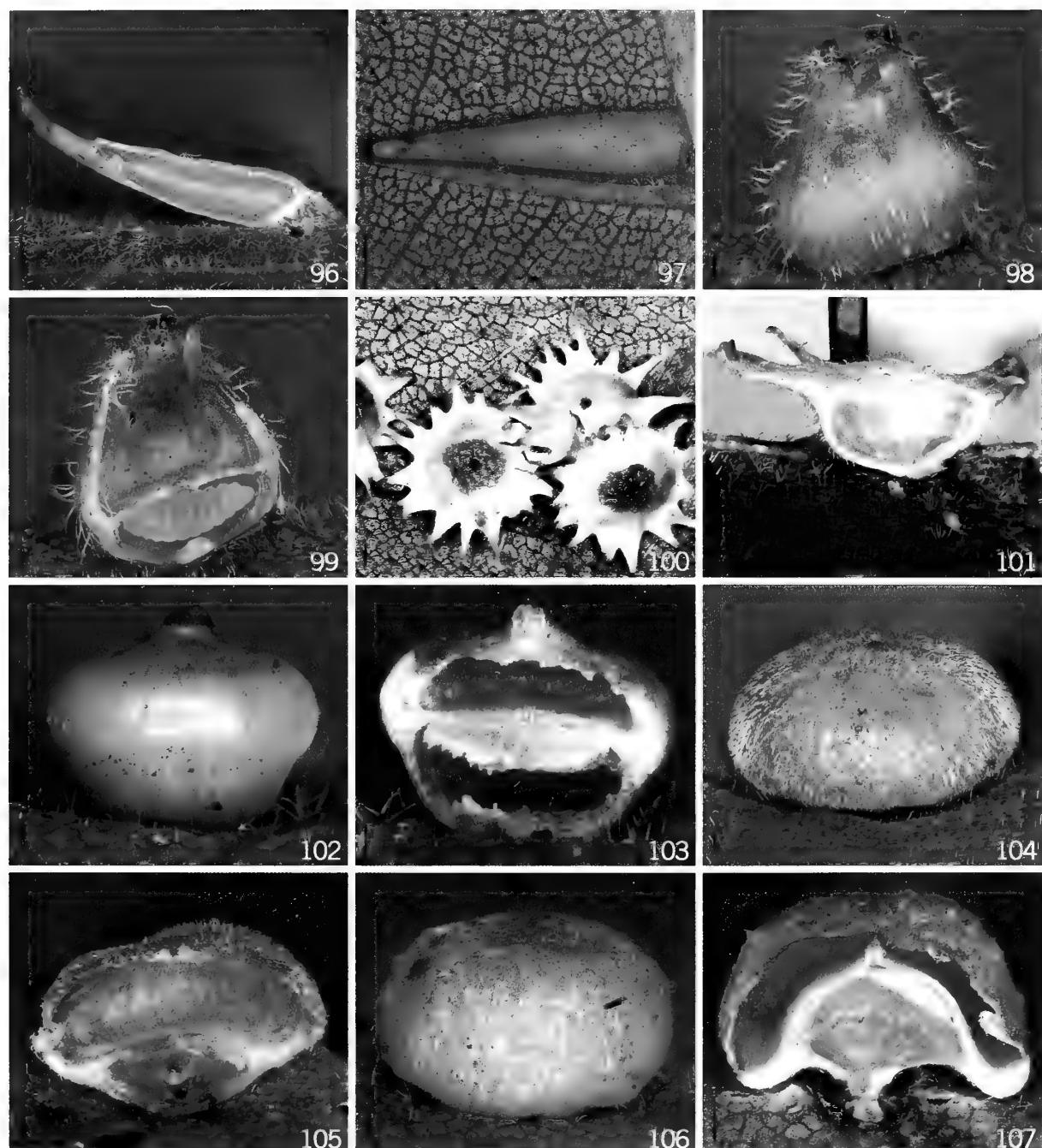
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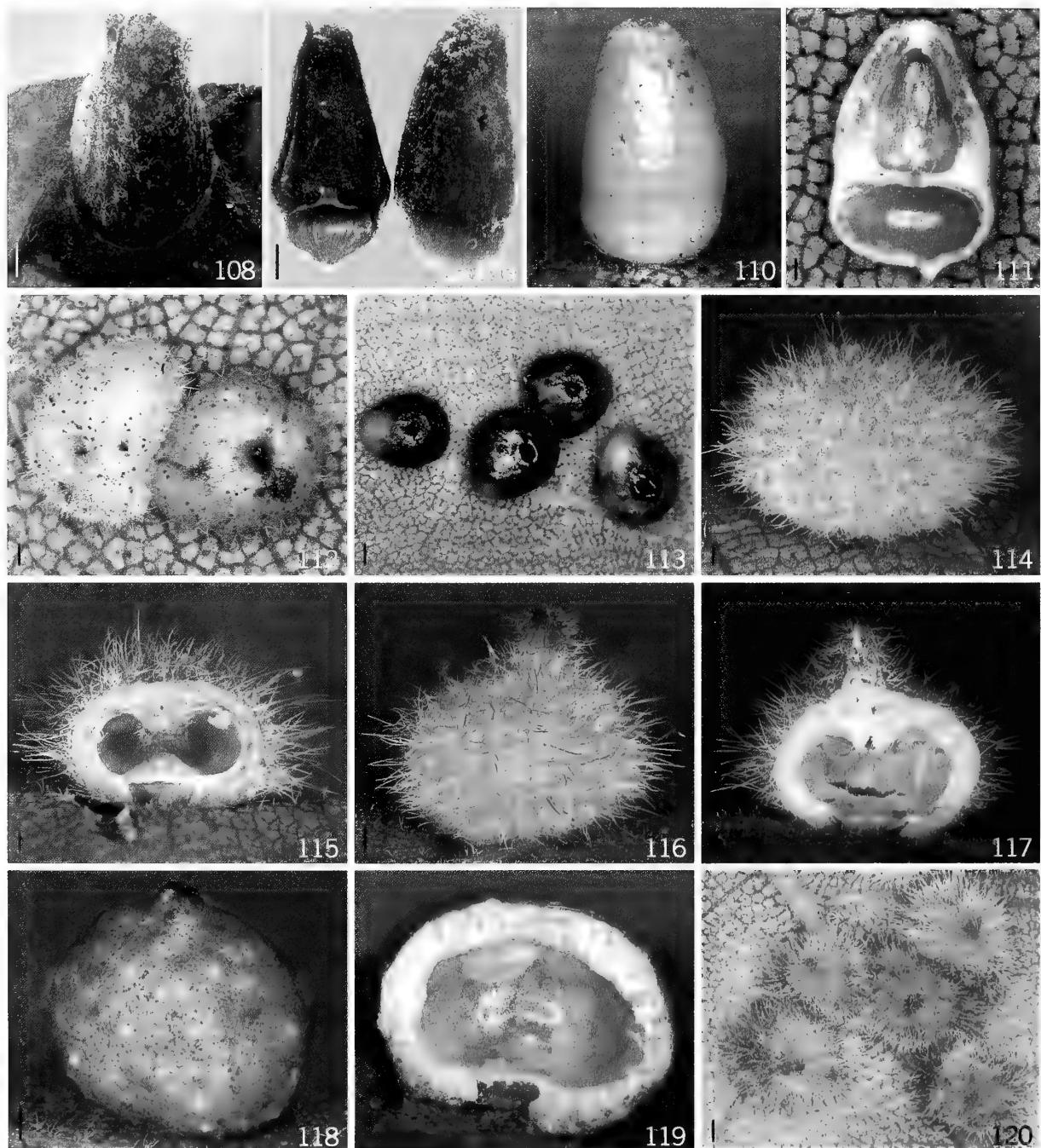
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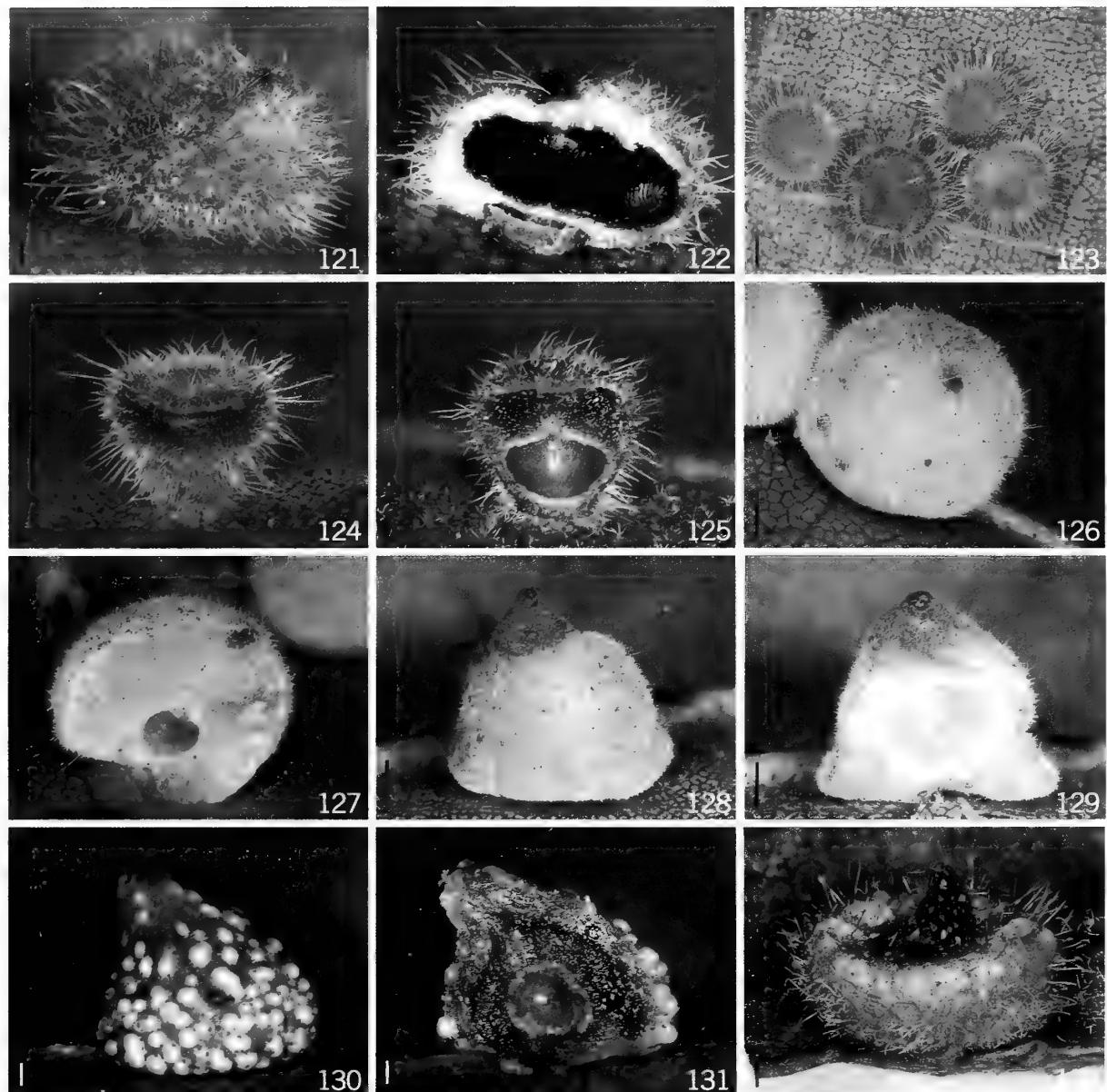
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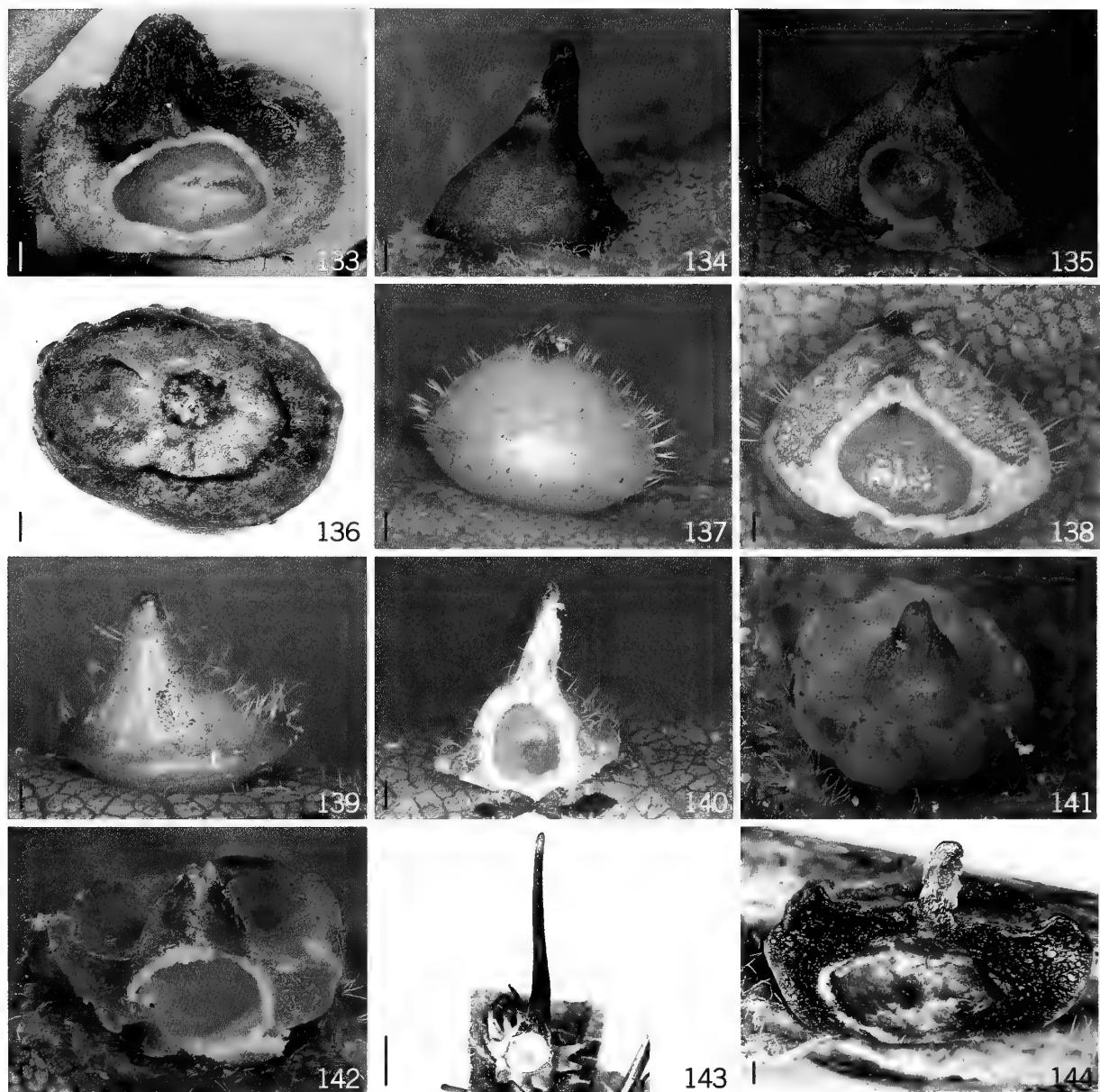
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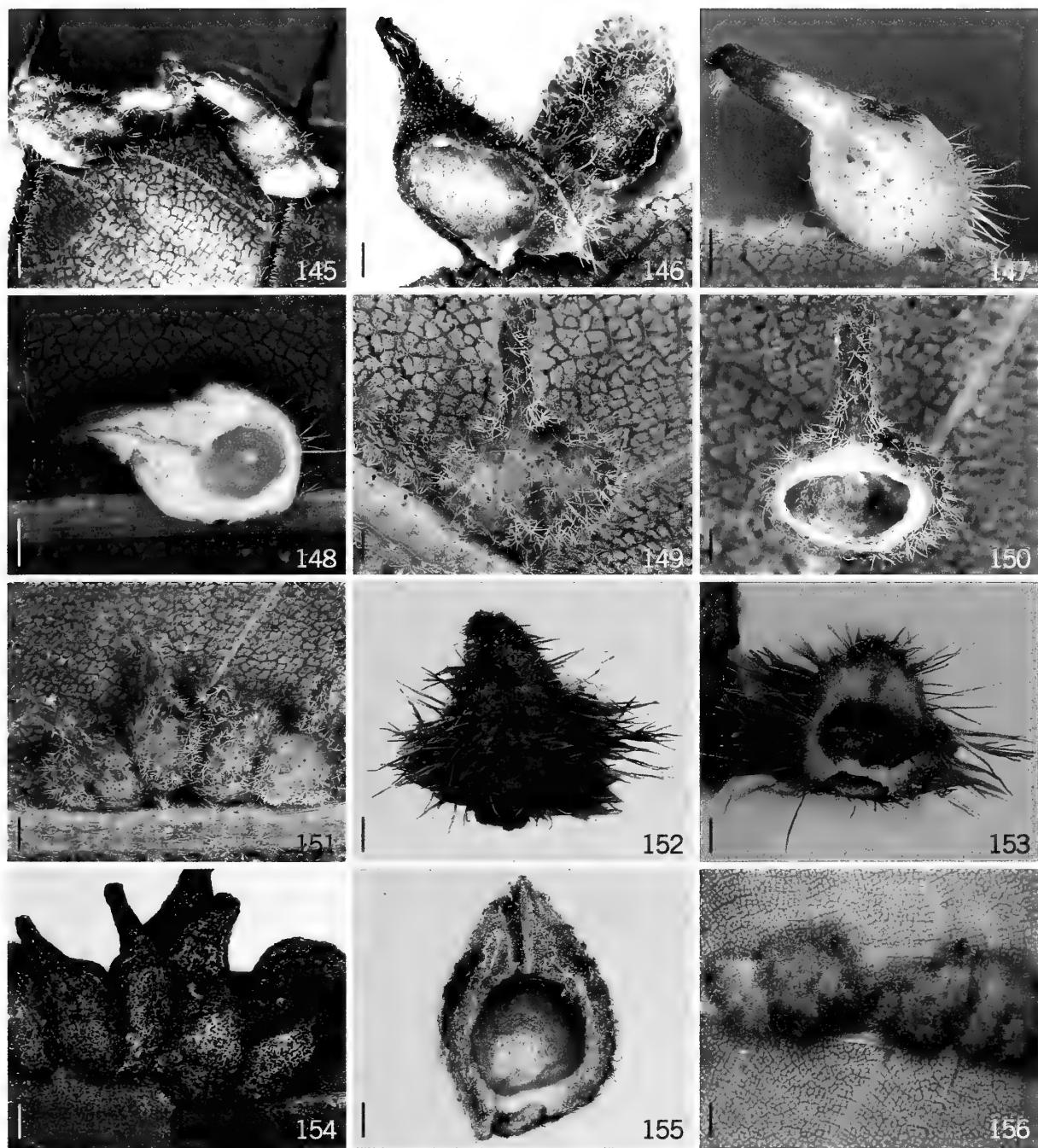
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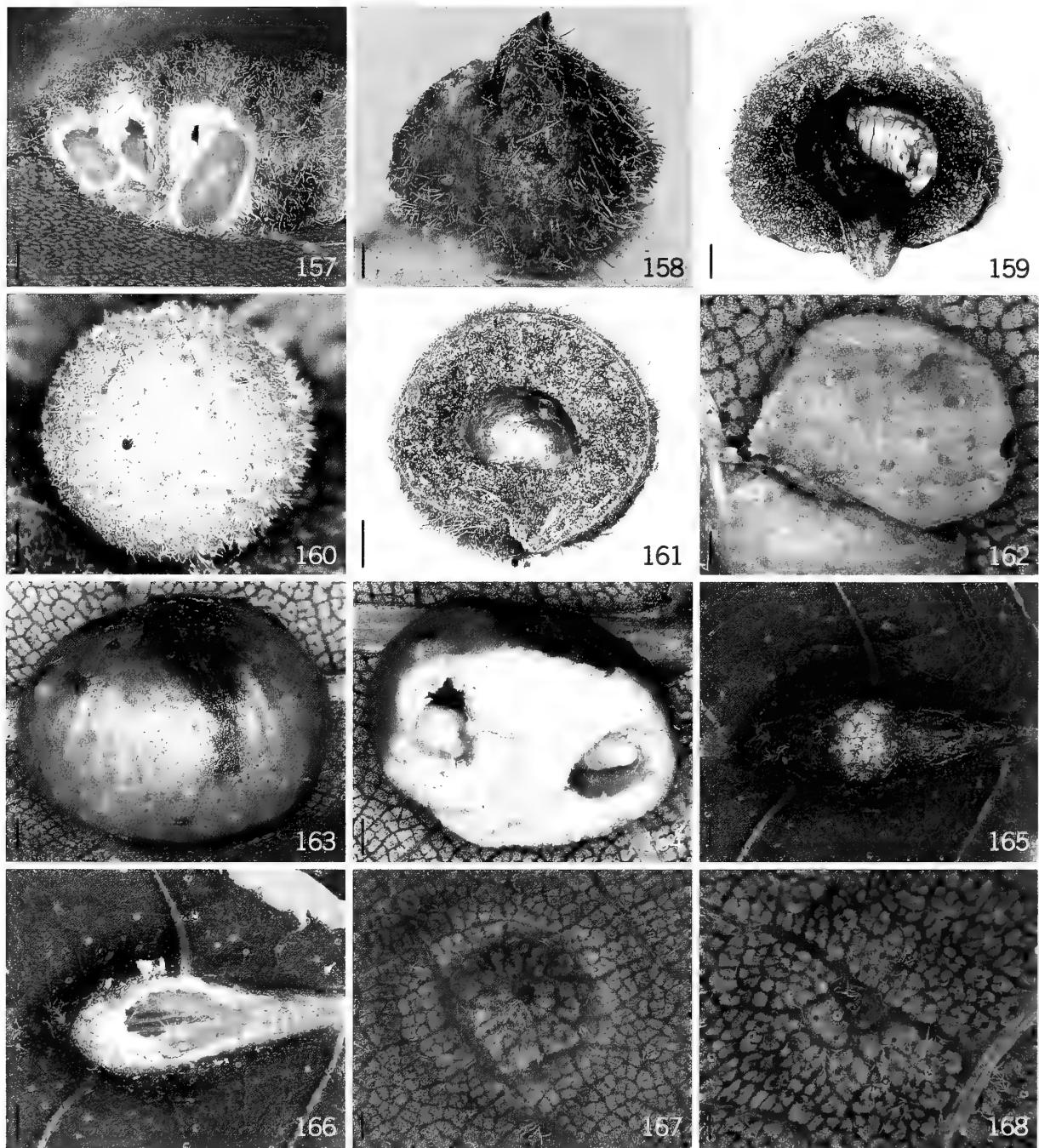
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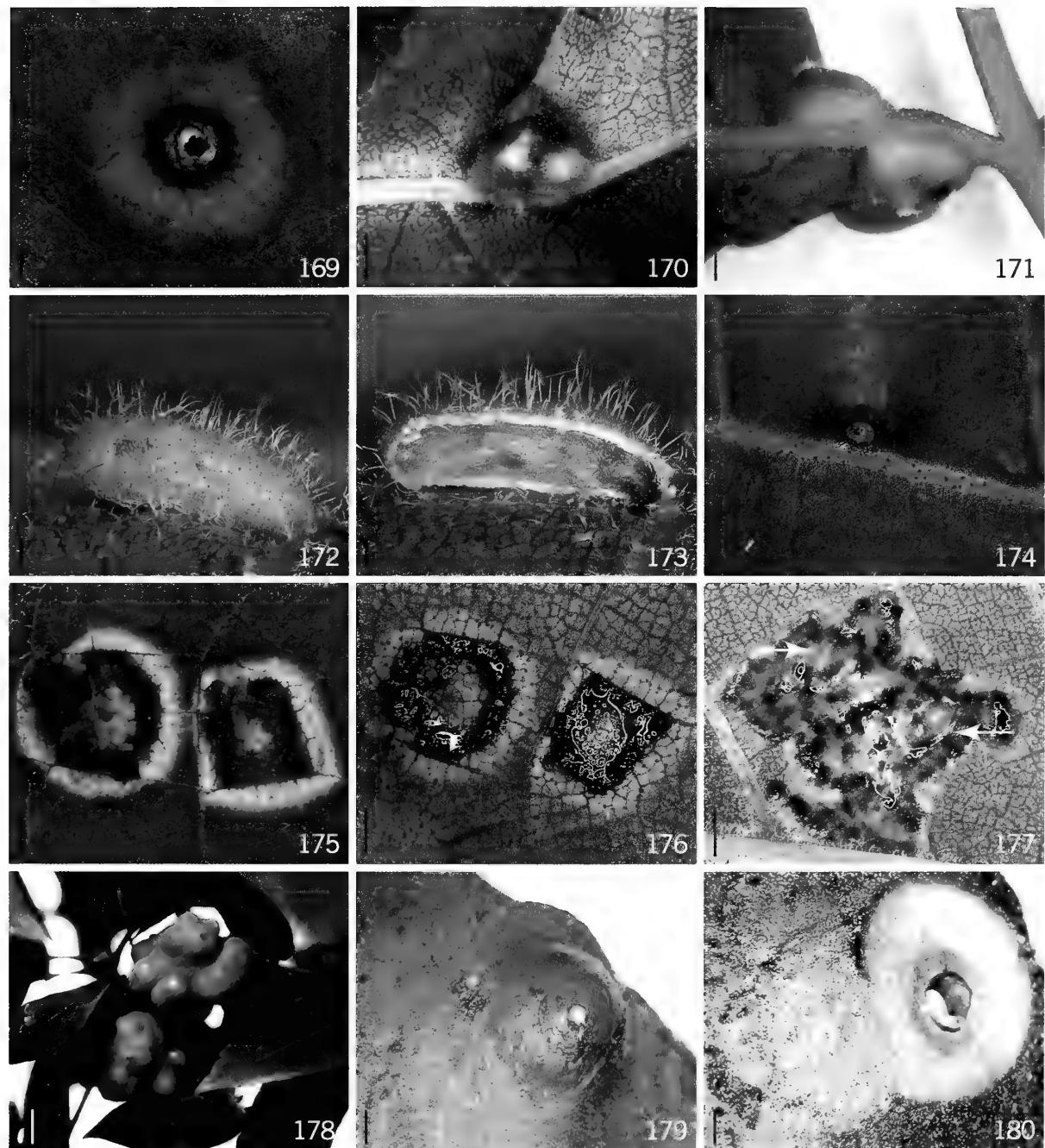
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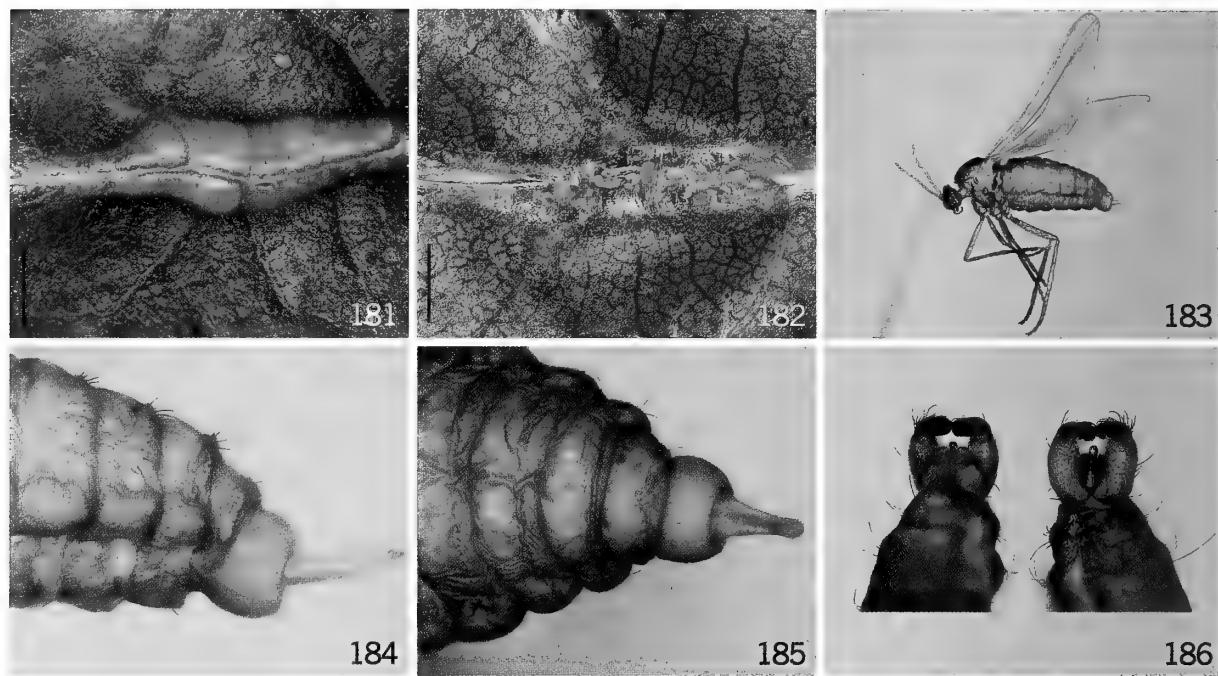
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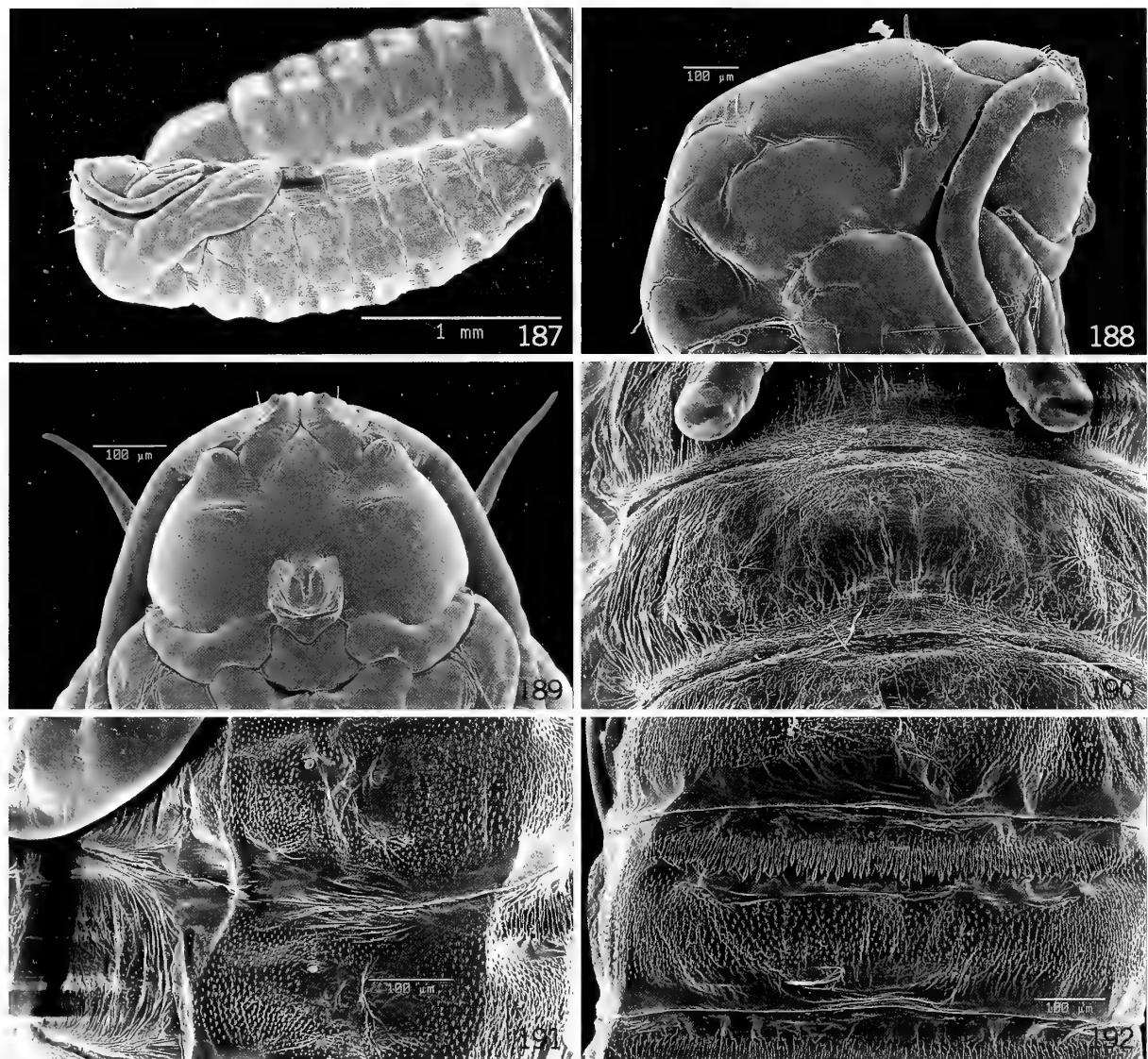


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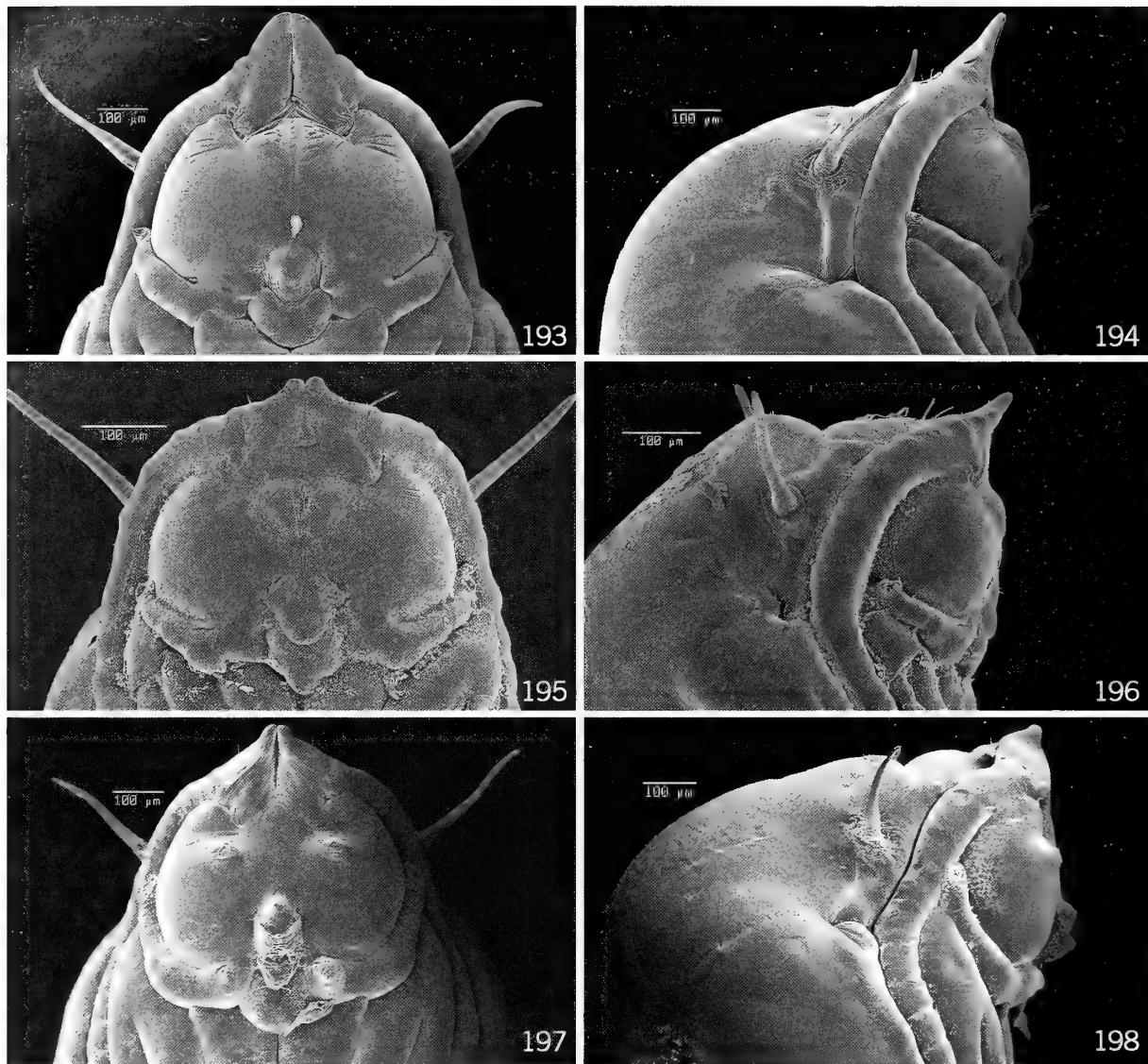


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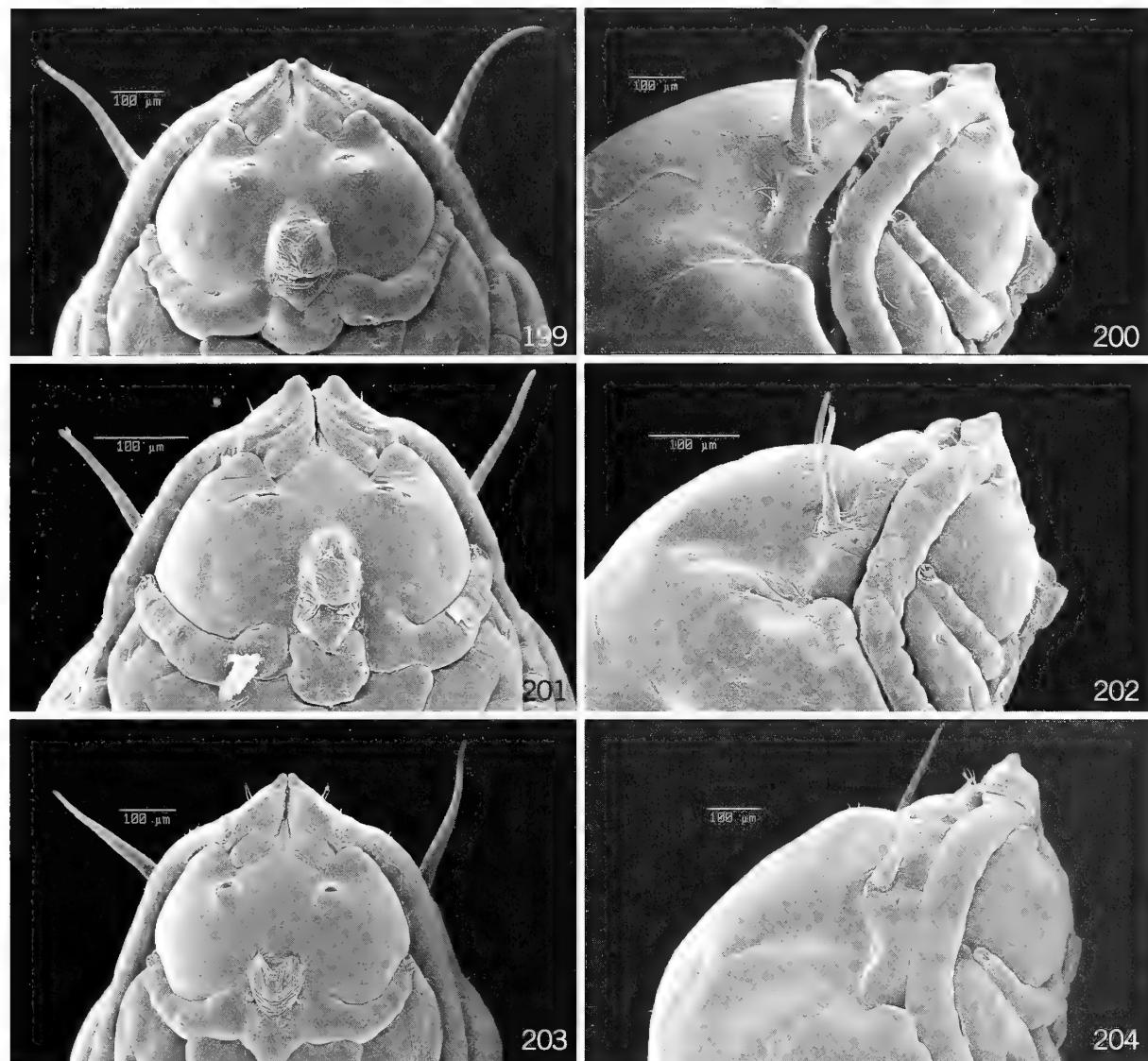
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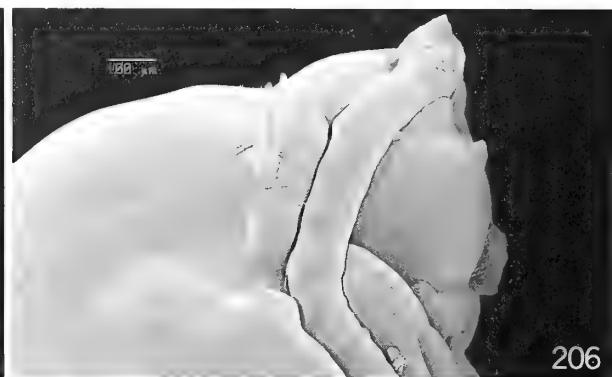
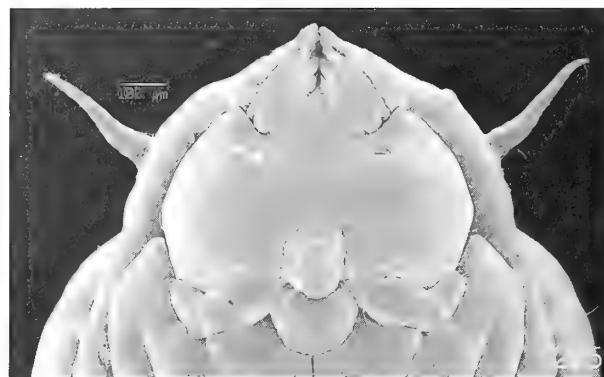
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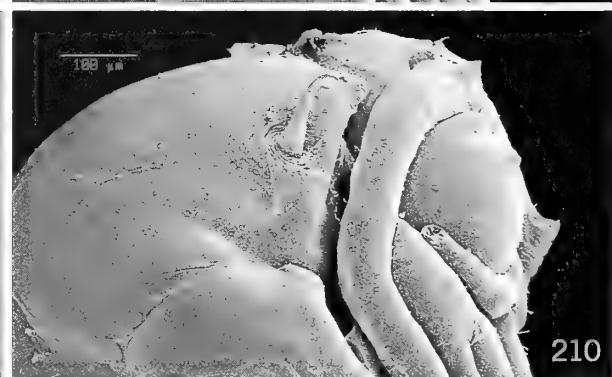
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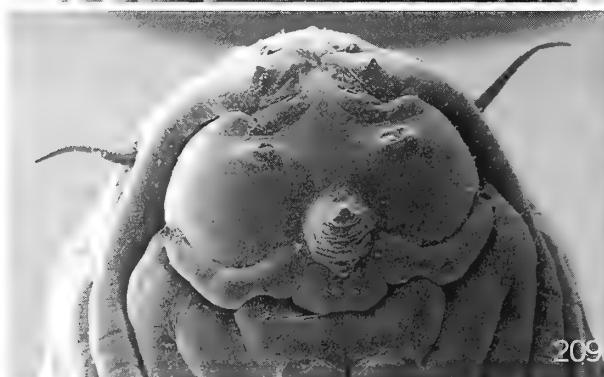
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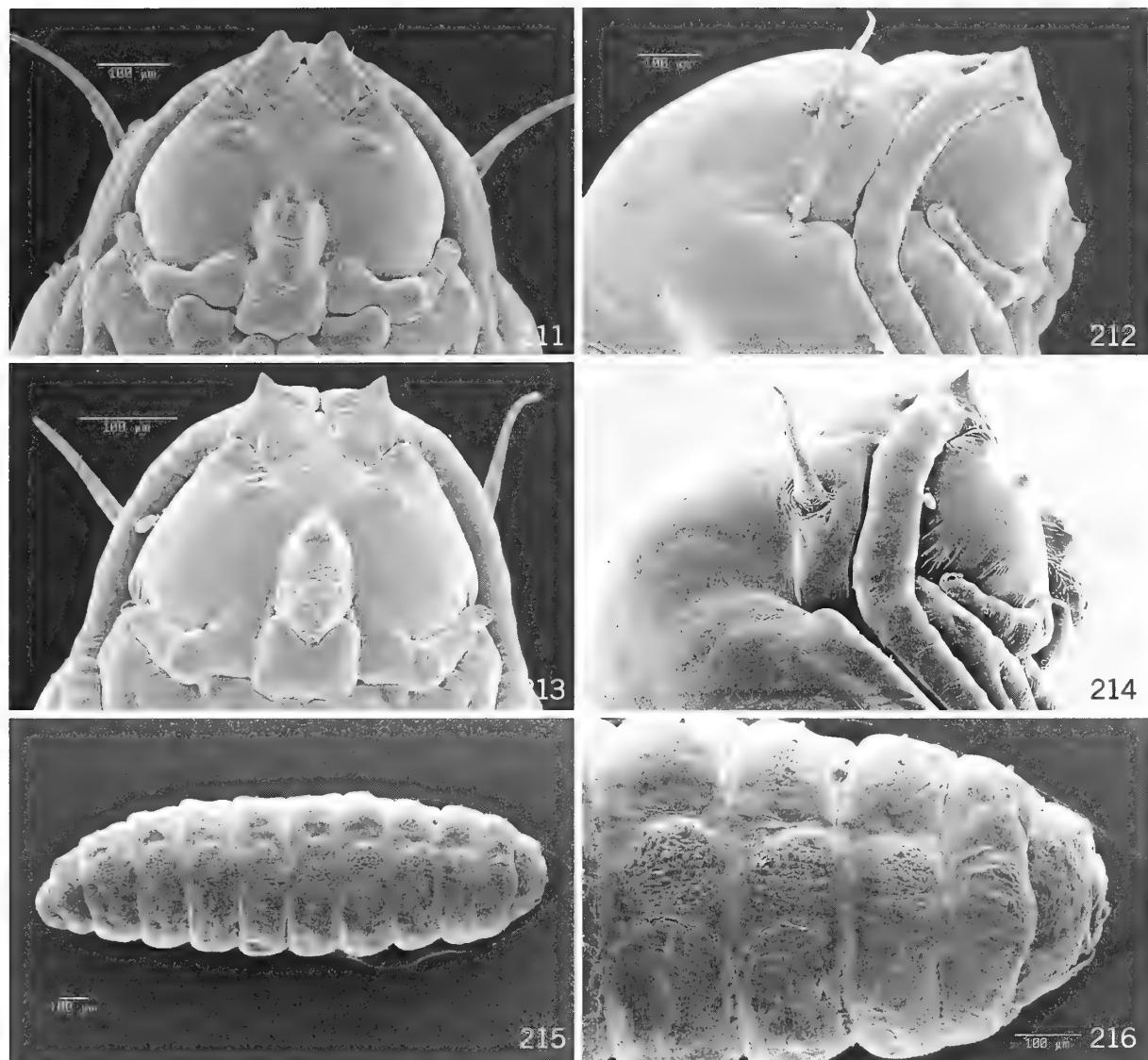


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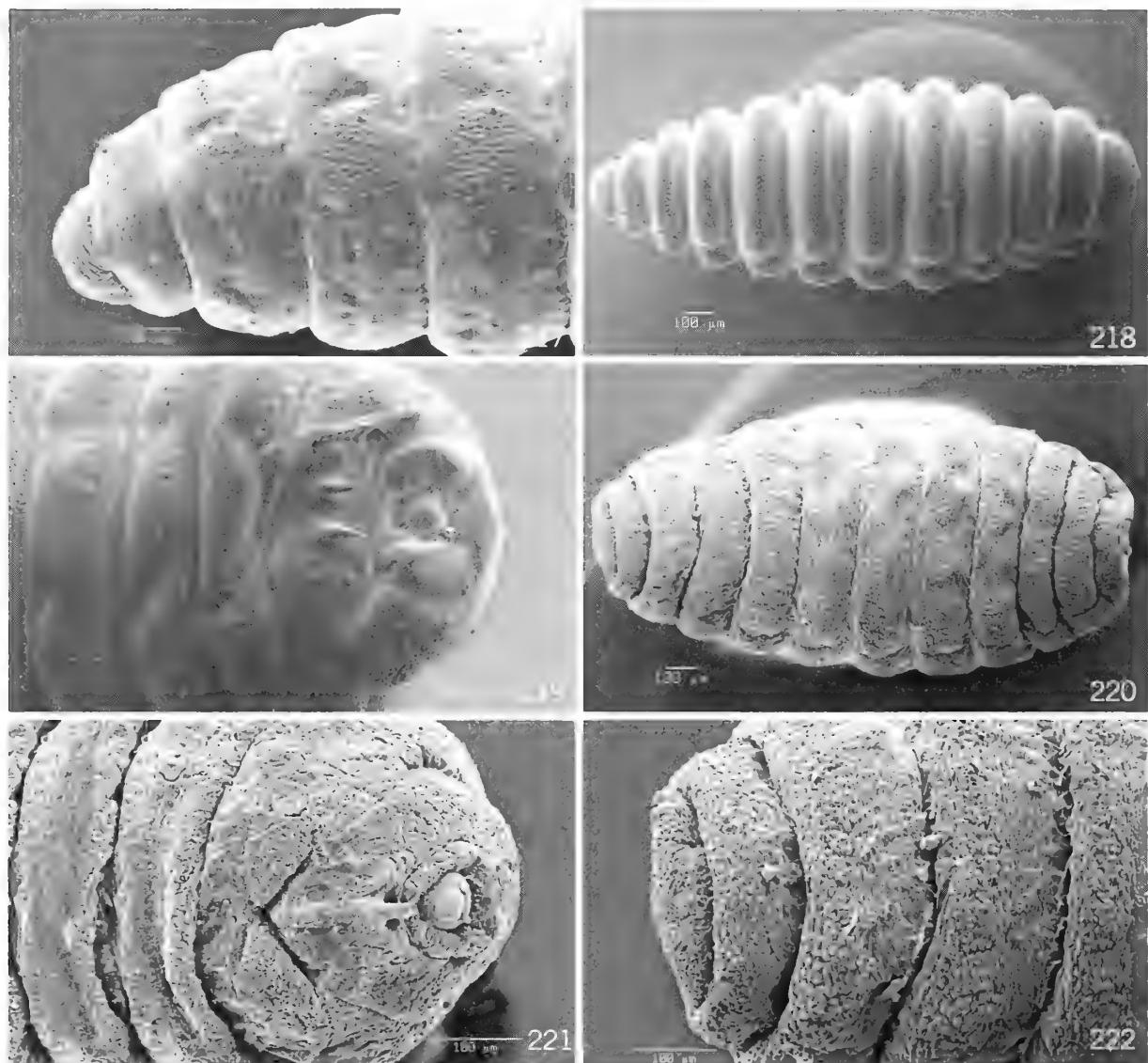


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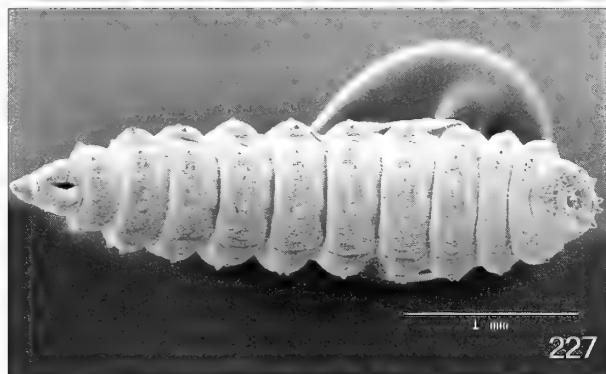
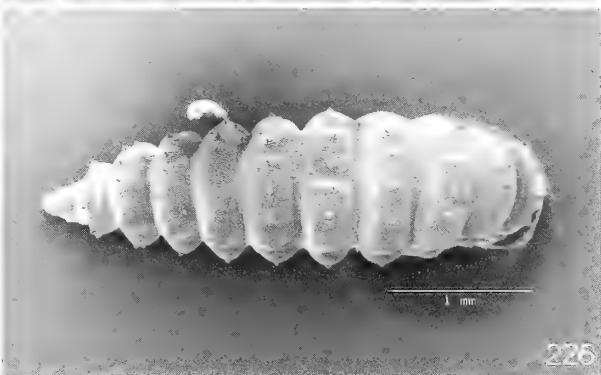
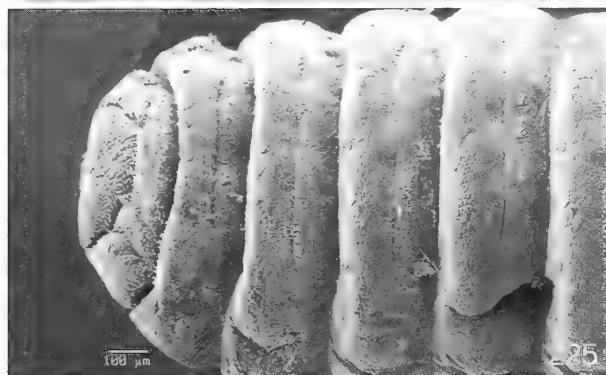
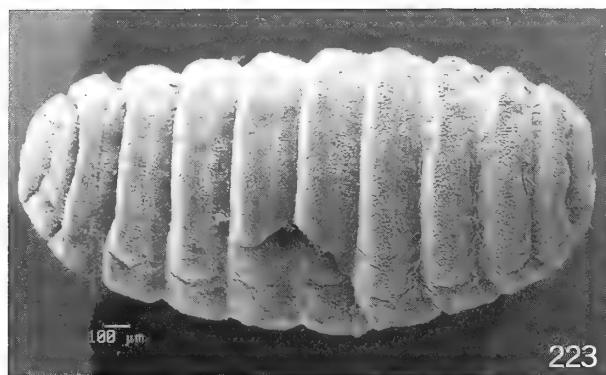
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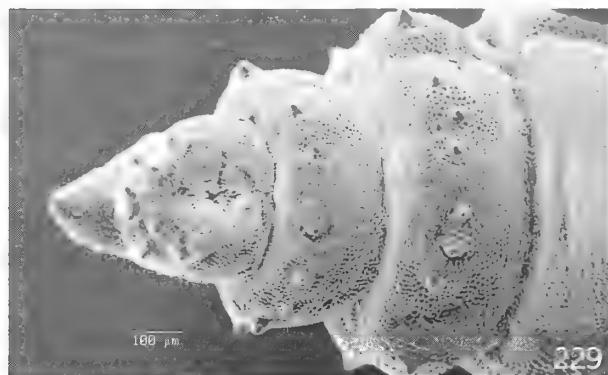
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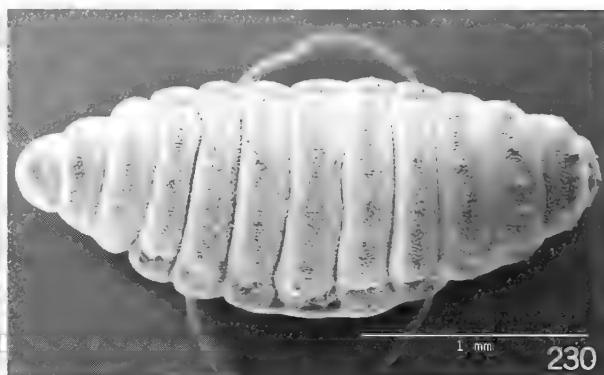
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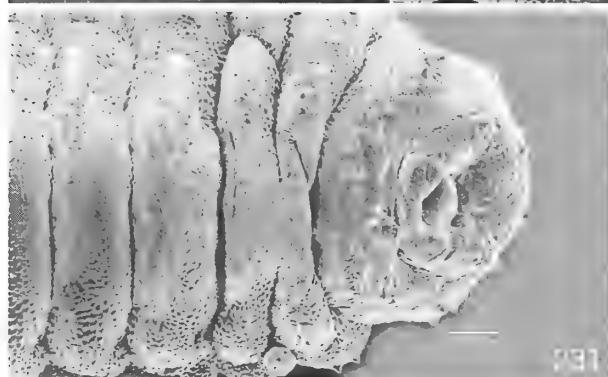
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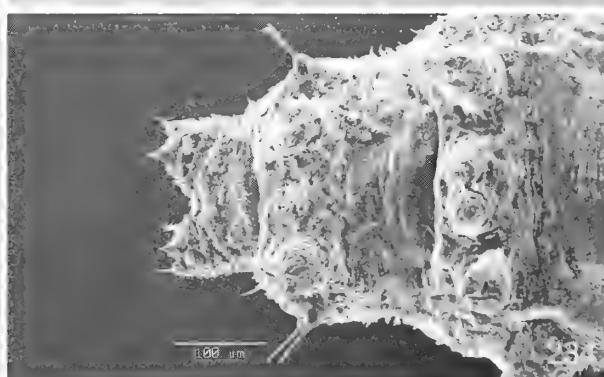
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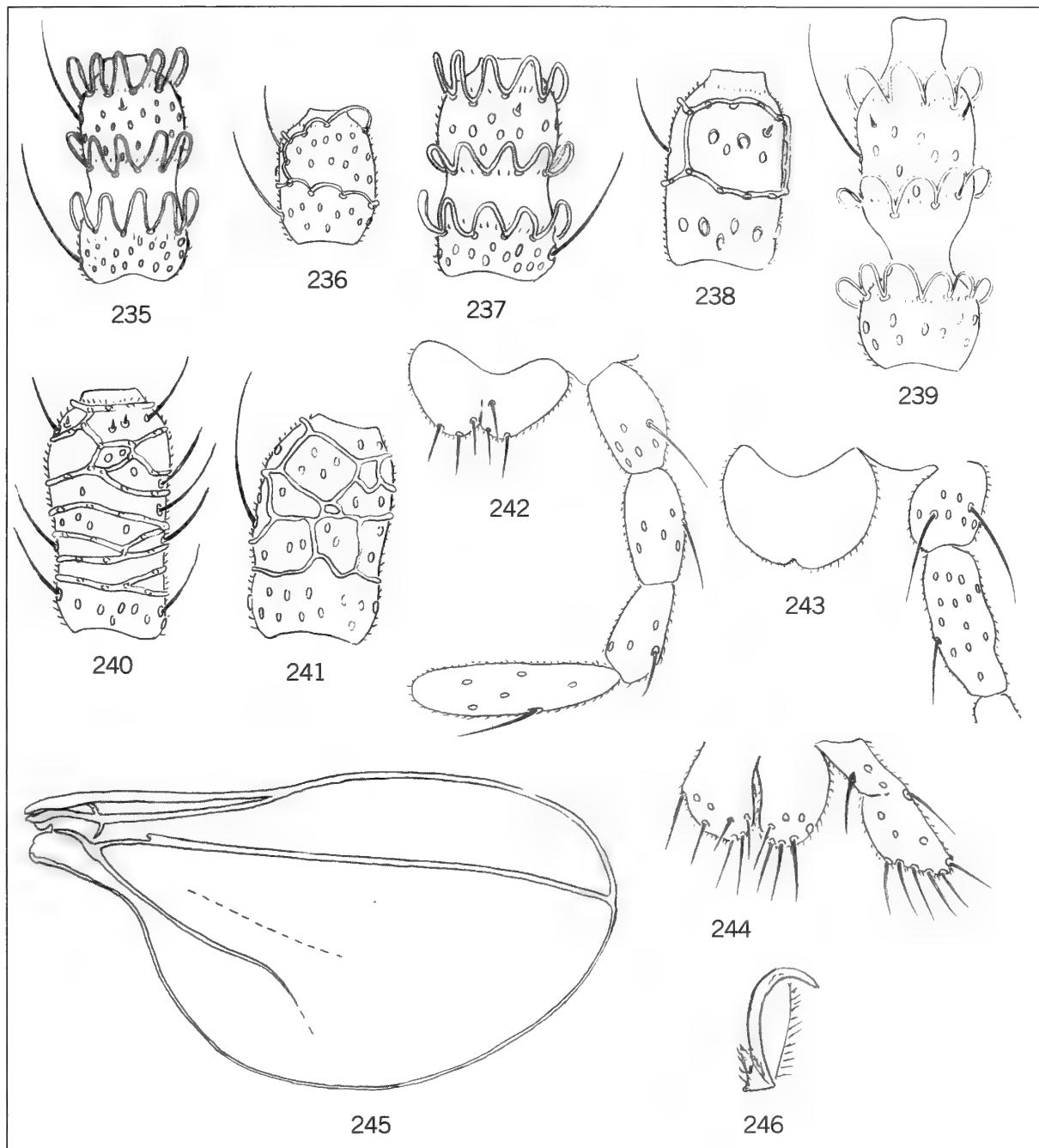
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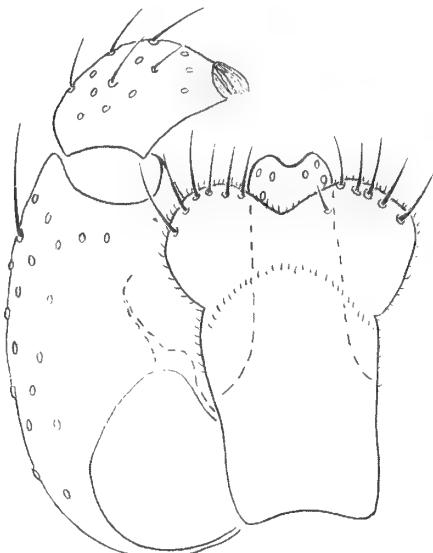
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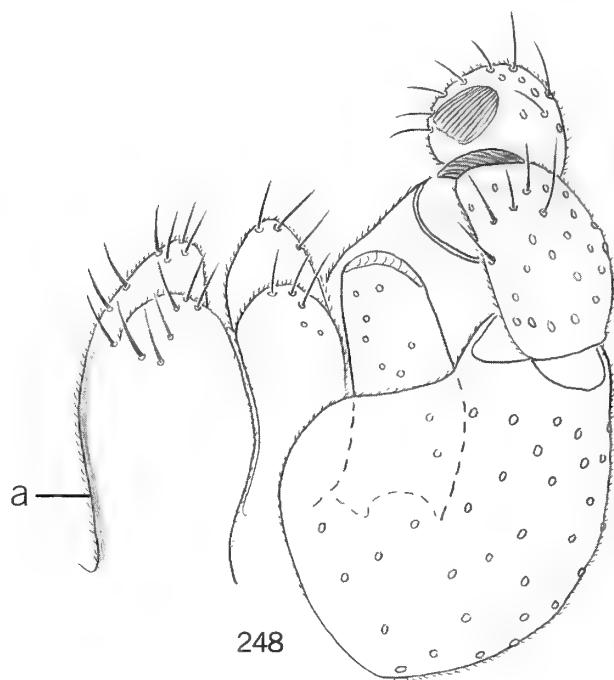
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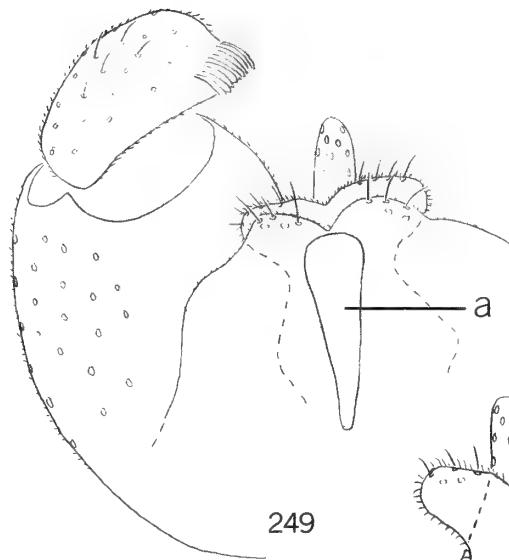
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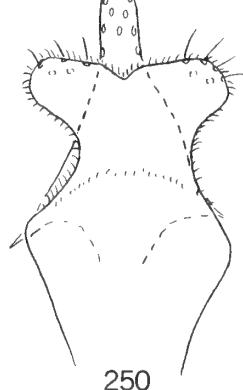
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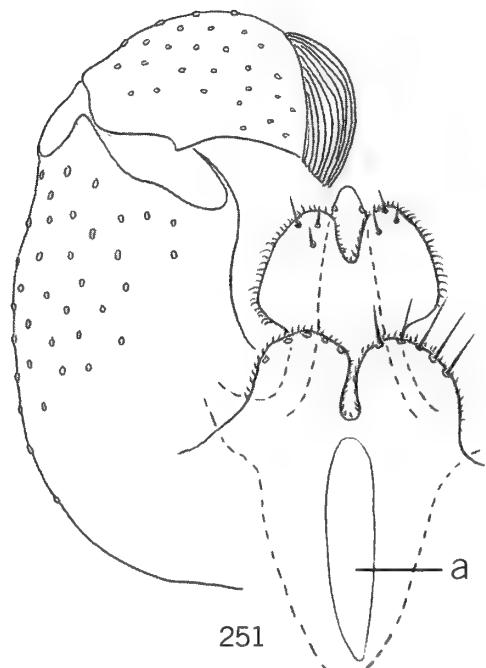
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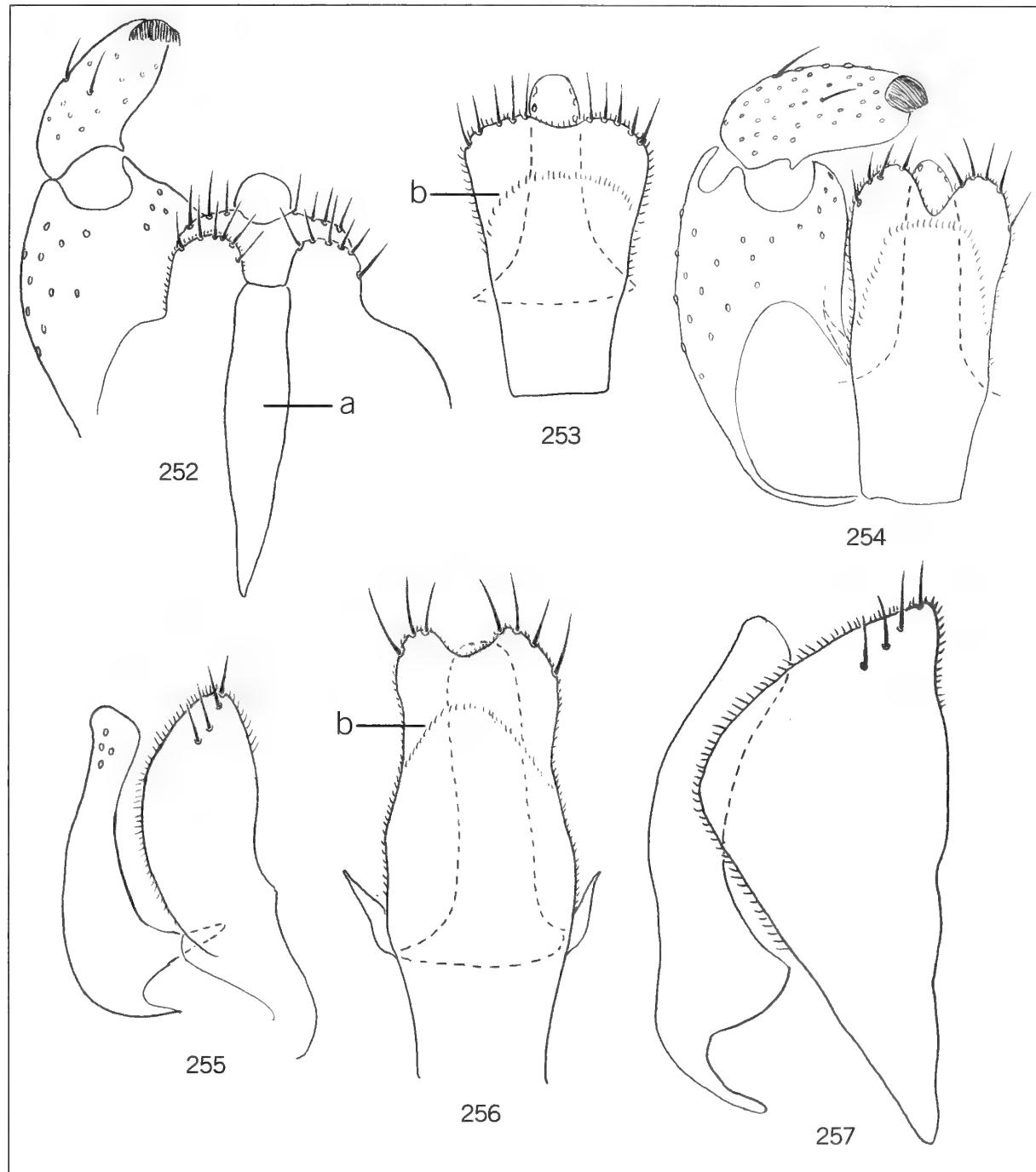


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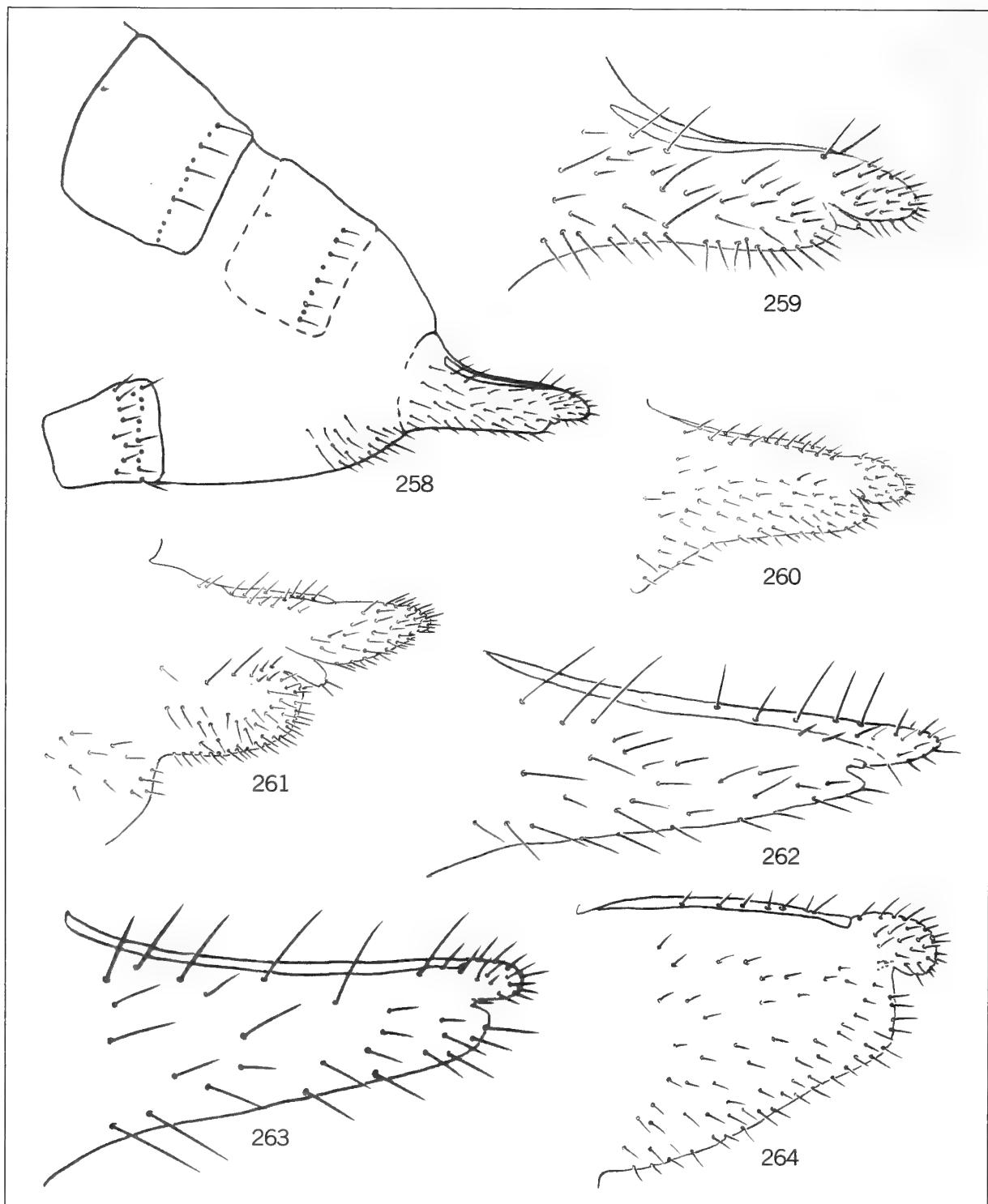


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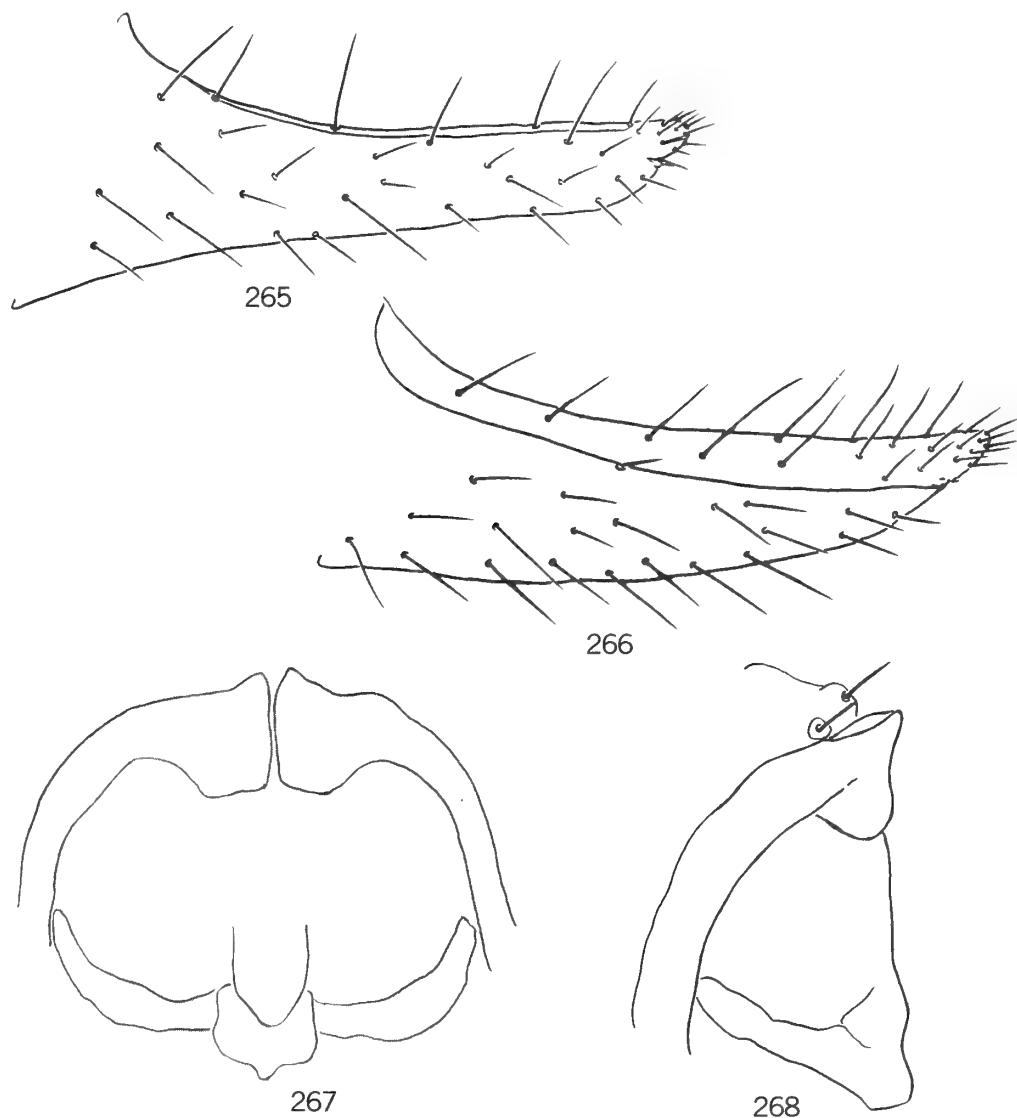
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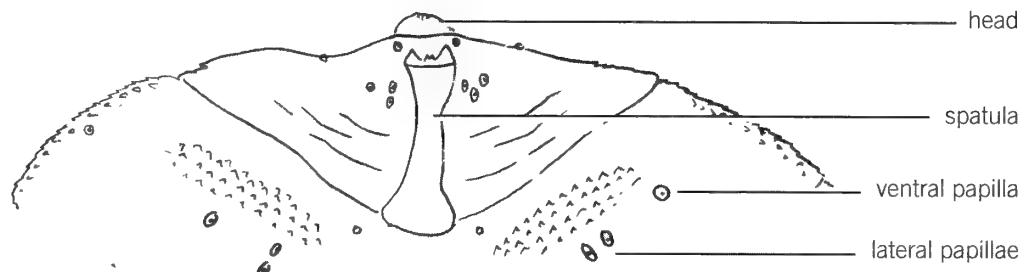
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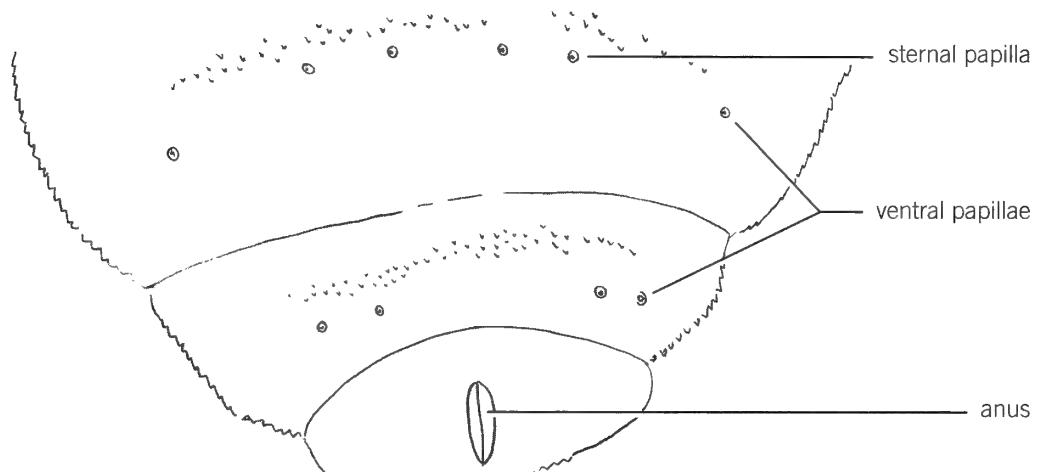
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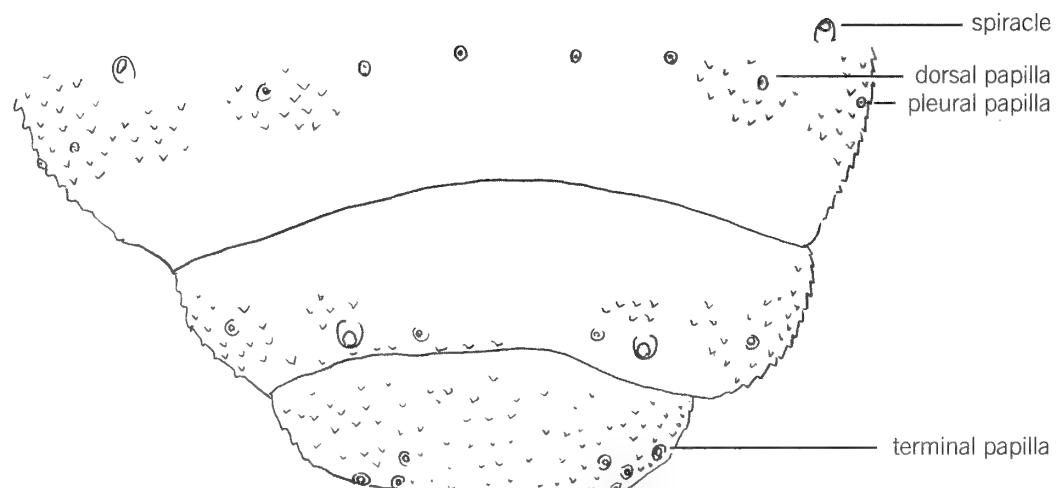
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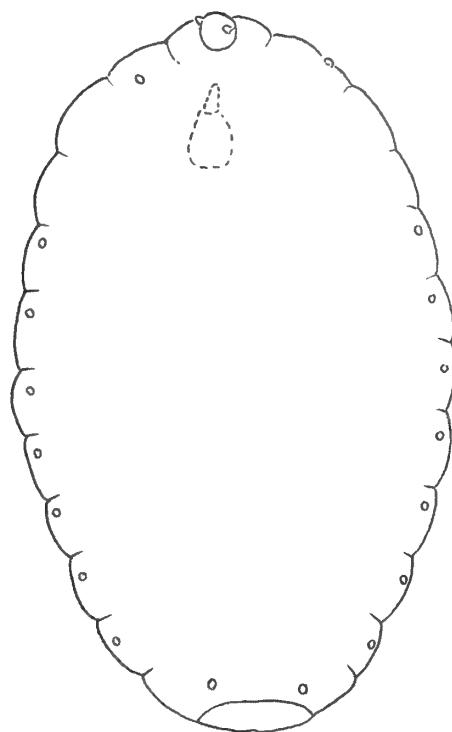


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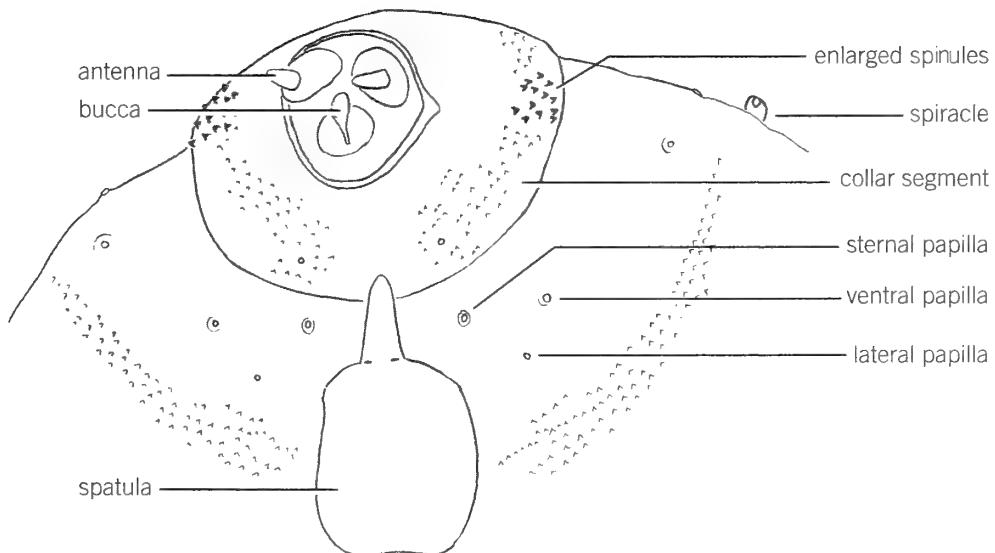


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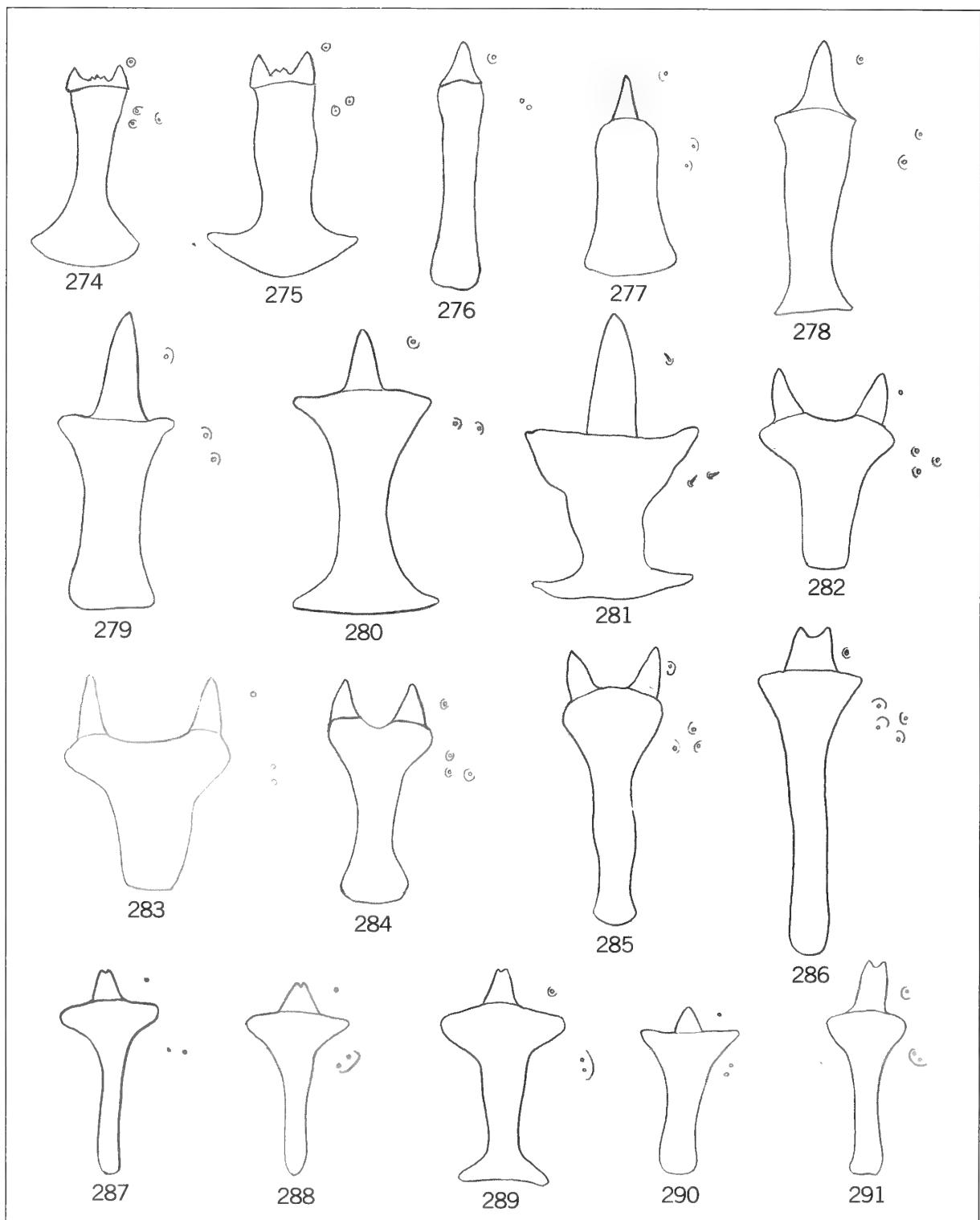


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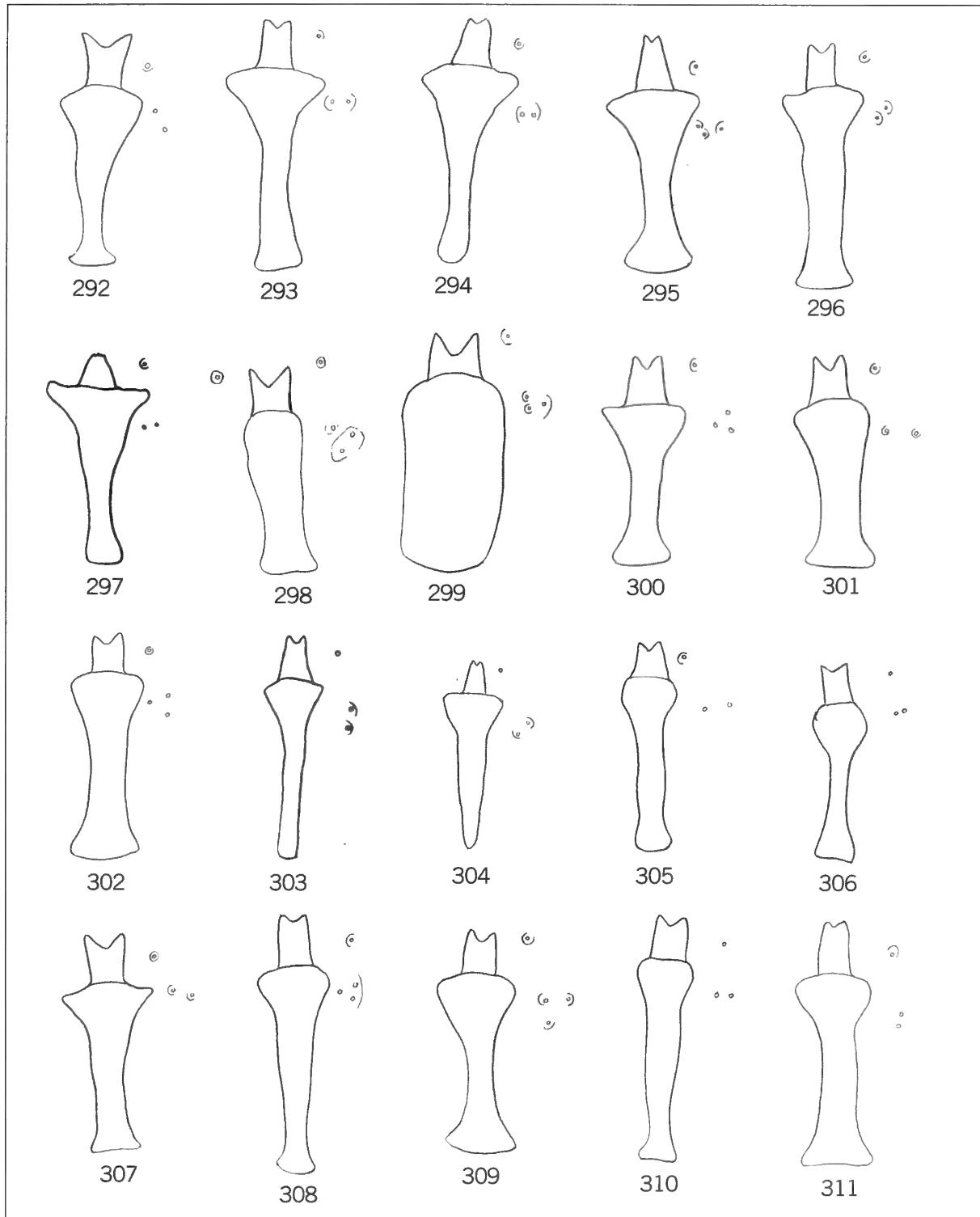


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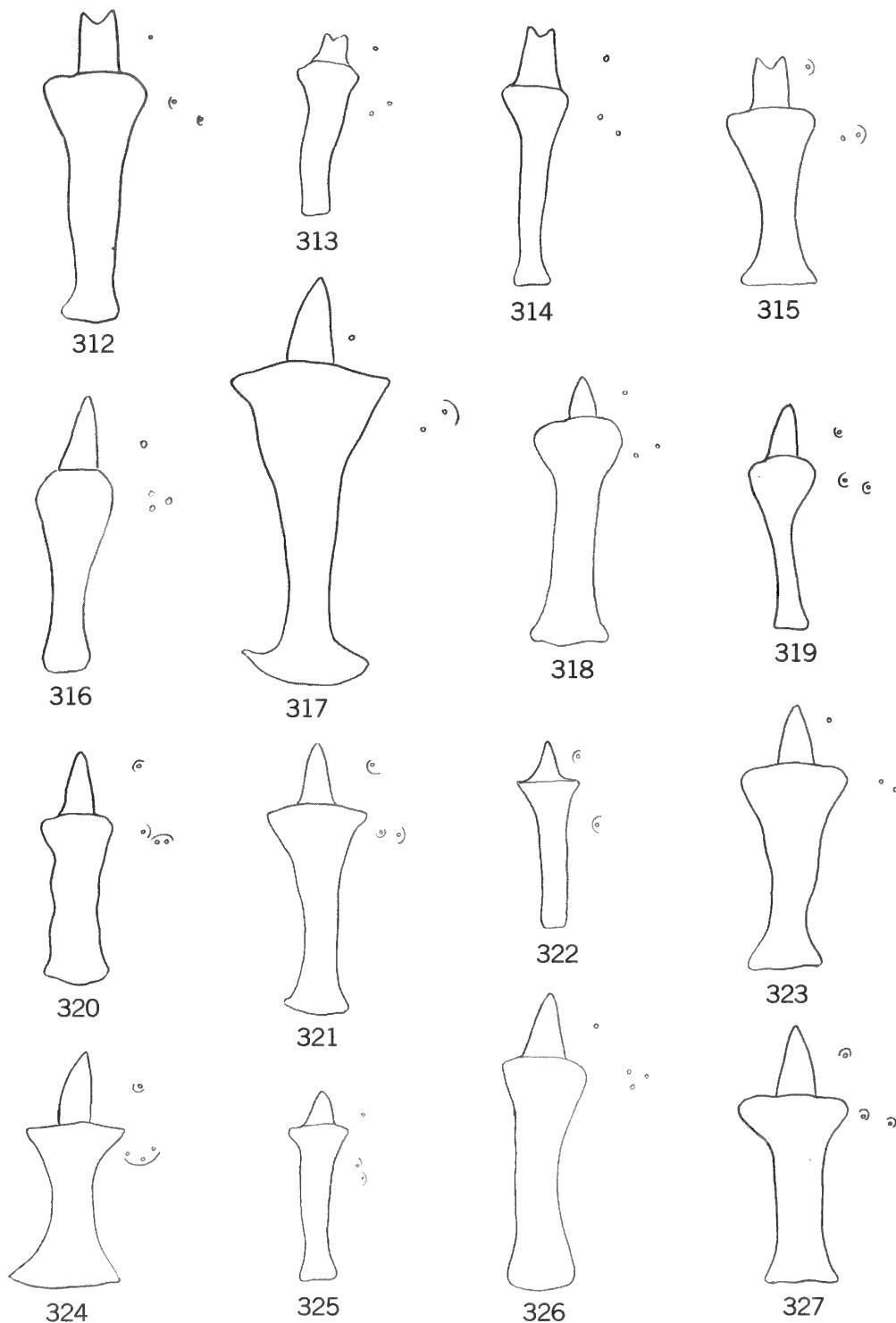
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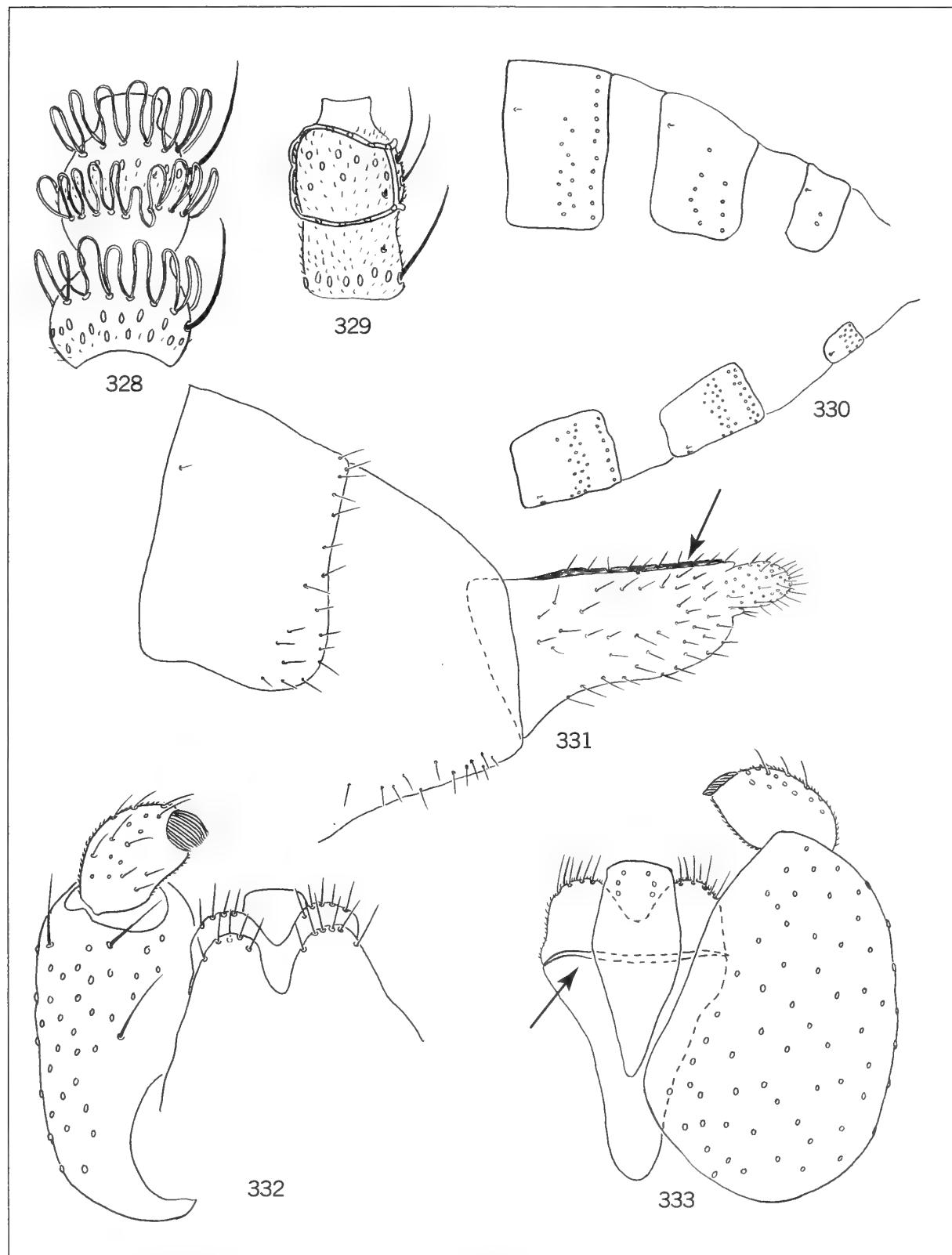
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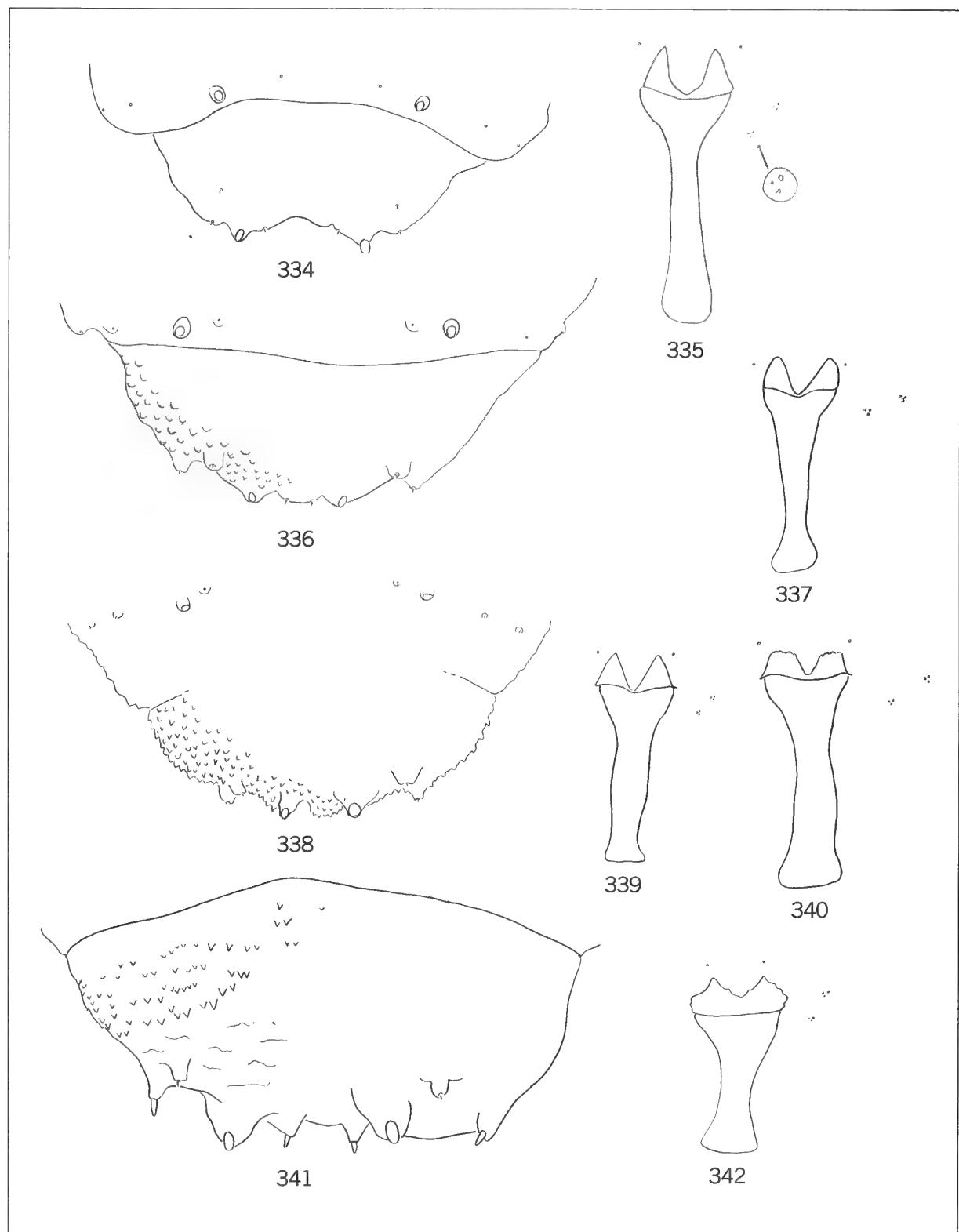
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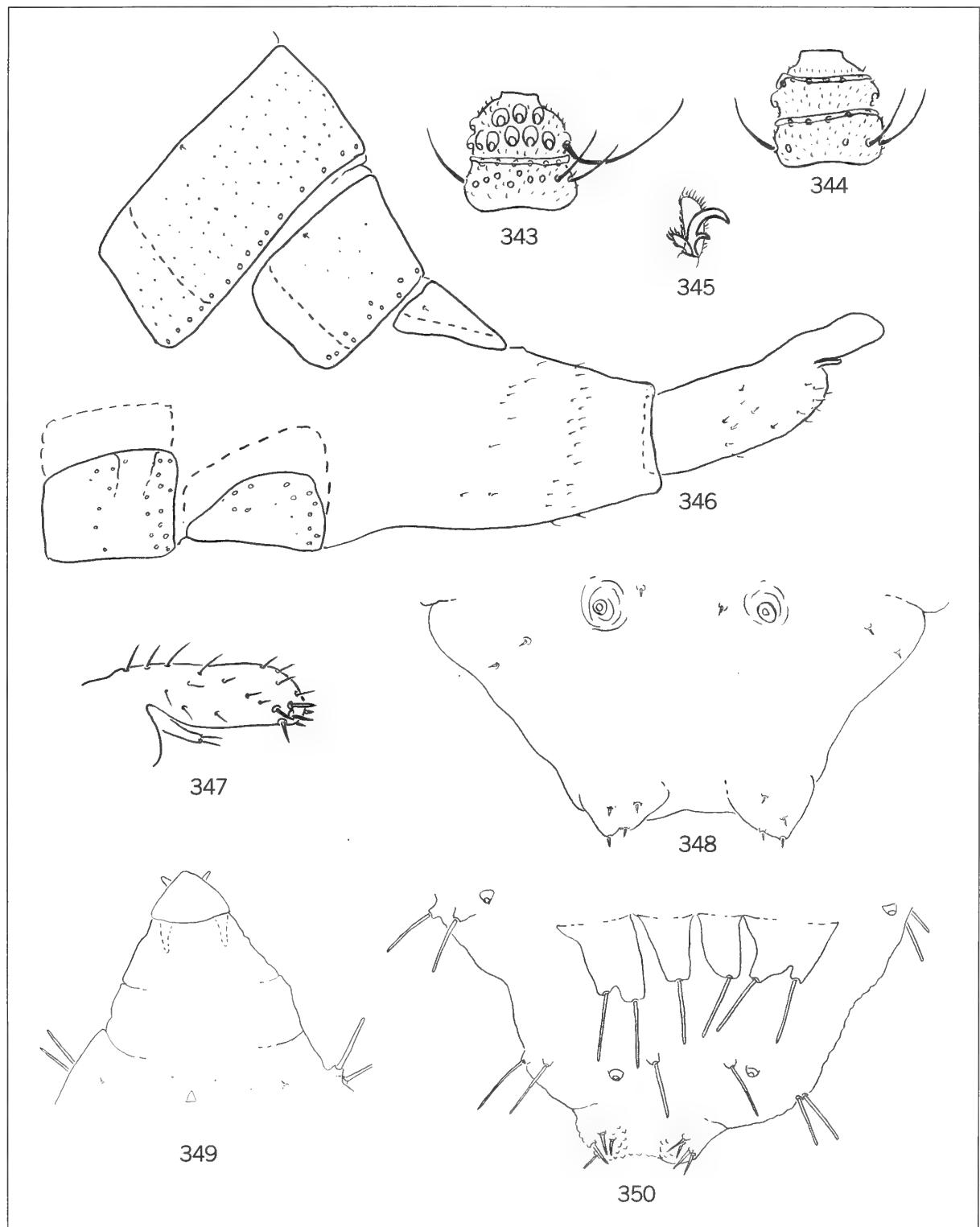
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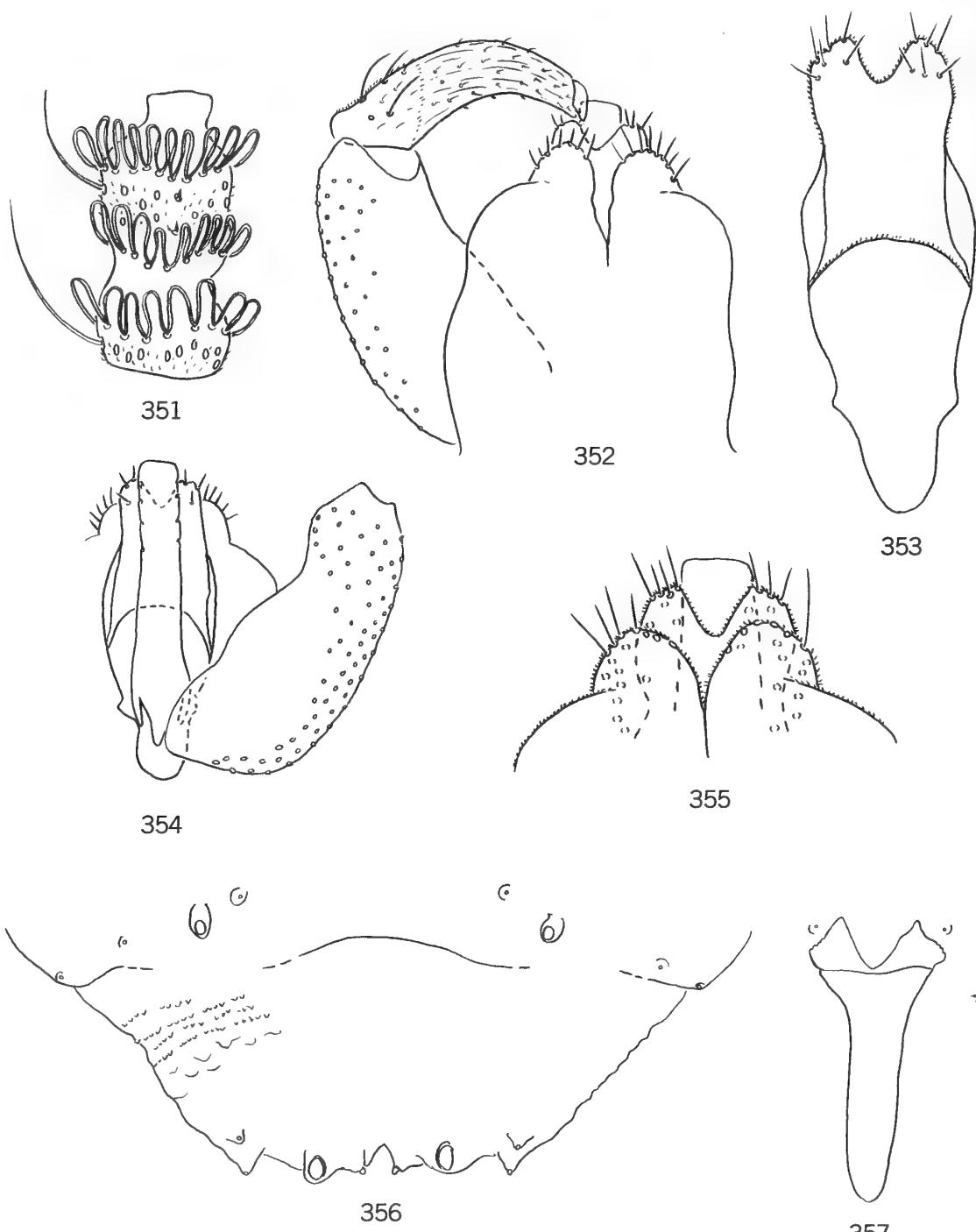
Figs. 328–333. *Caryadiplosis venicola*. 328, Male third flagellomere. 329, Female third flagellomere. 330, Male abdomen, segments 6–8. 331, Female abdomen, segments 8 to end (arrow denotes sclerite on ninth segment). 332, Male genitalia, dorsal. 333, Same, ventral, cerci removed (arrow denotes horizontal ridge at hypoproct mid-length).



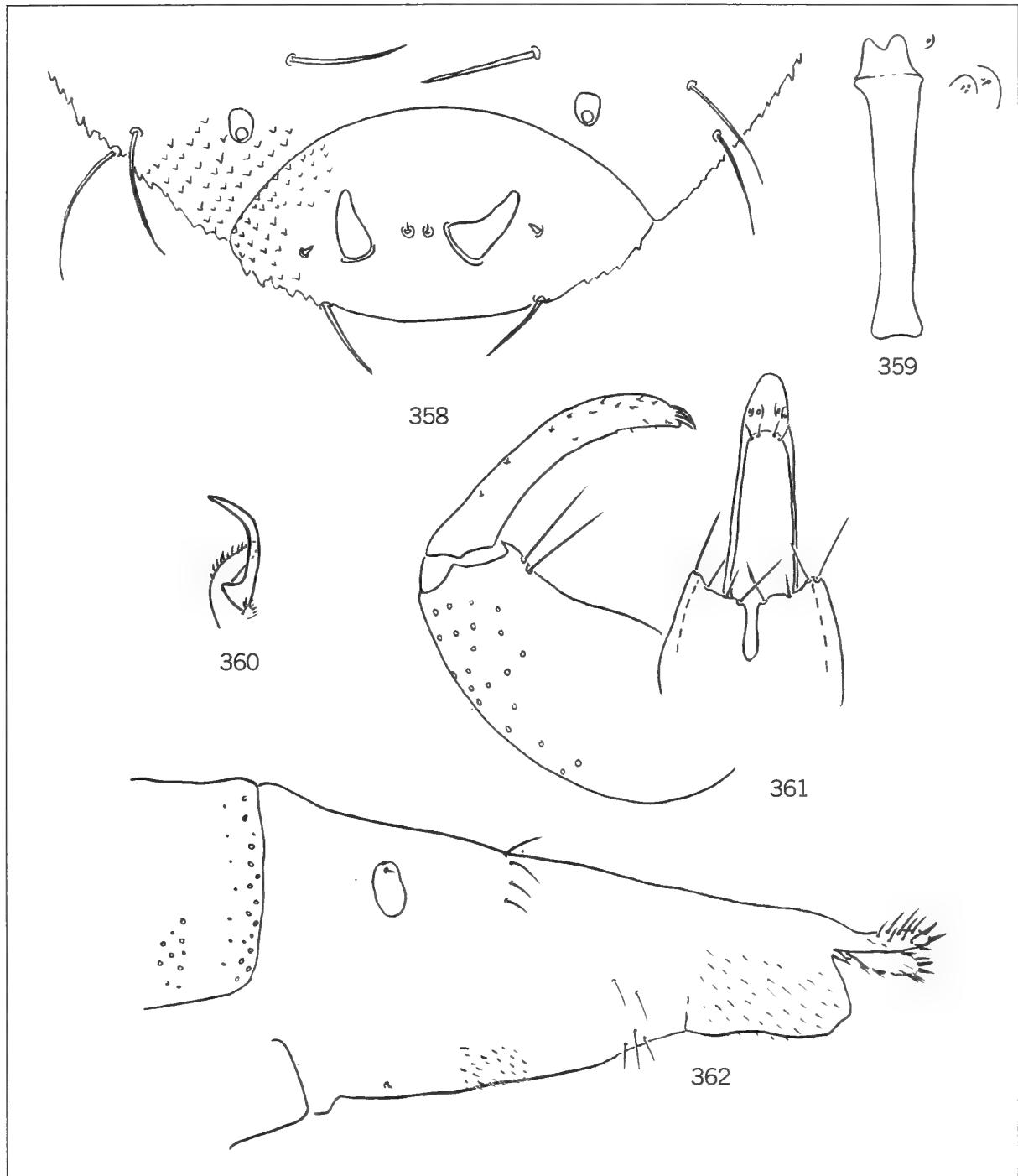
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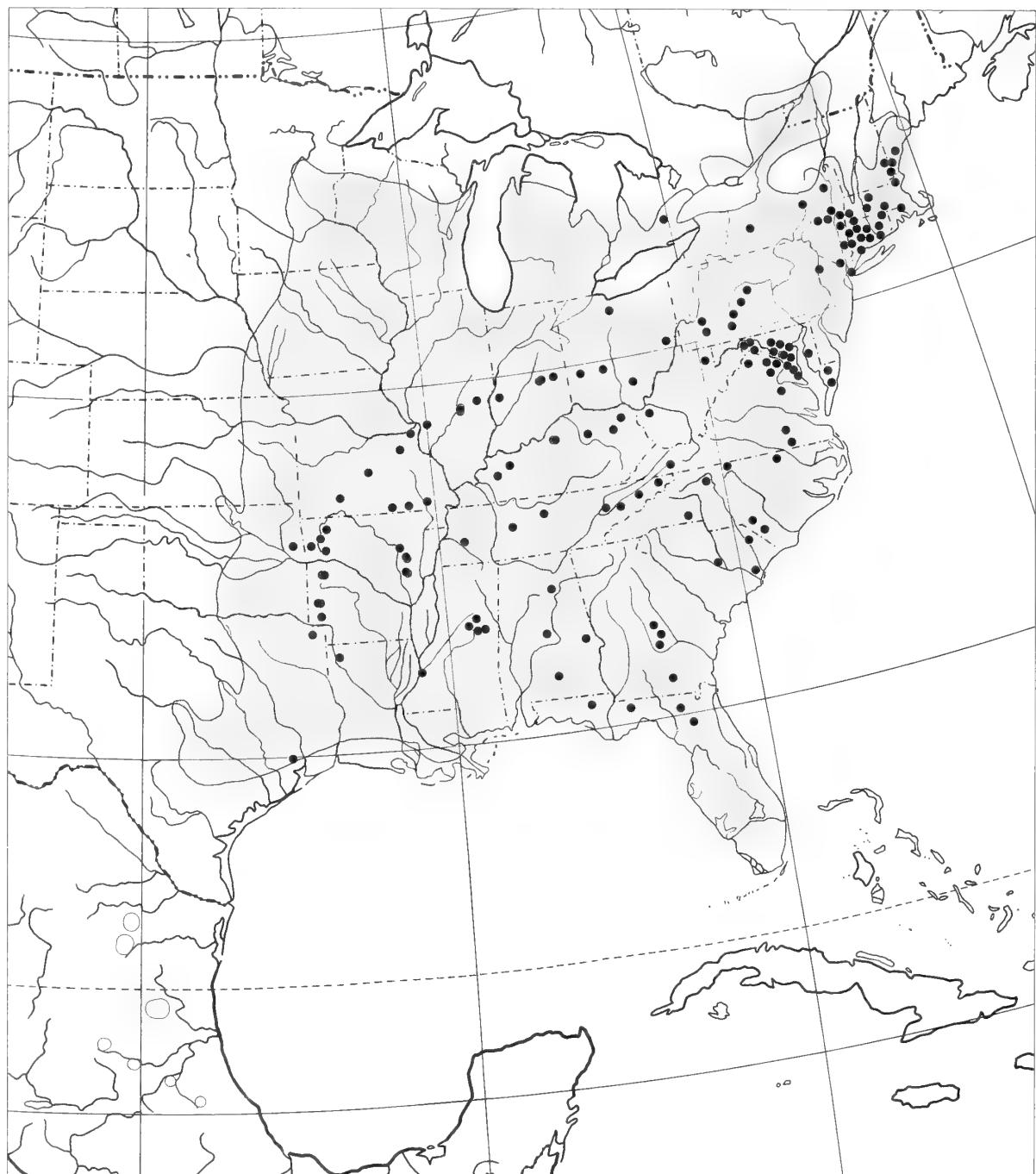
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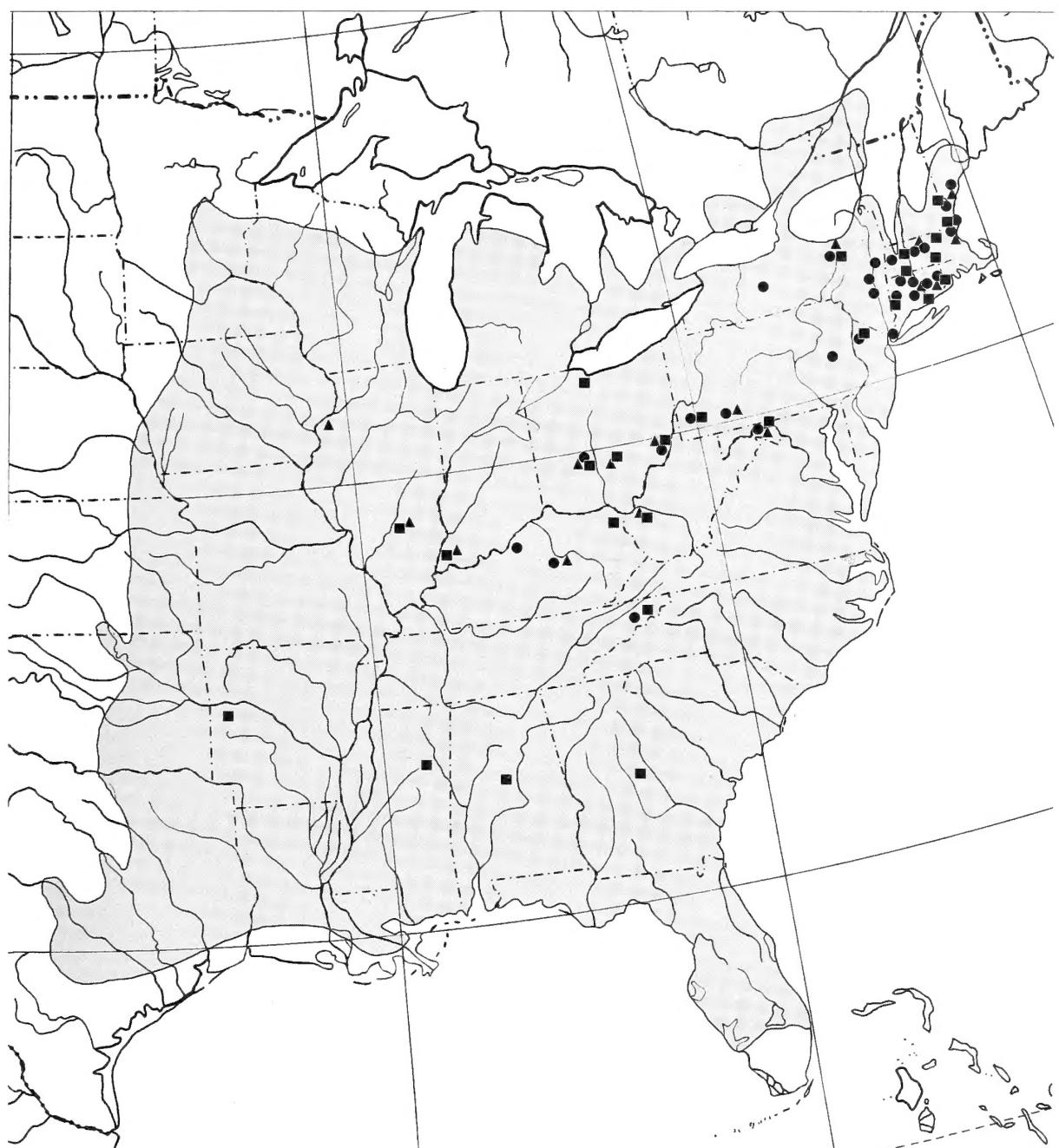
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Map 1. Distribution of *Caryomyia tubicola* (circles) superimposed on natural range of hickories (gray area, based on Fowells 1965 and Elias 1980) in North America. A circle may cover several adjacent collection sites.



Map 2. Distribution of *Caryomyia inanis* (circles), *C. inflata* (squares), and *C. lenta* (triangles), superimposed on natural range of hickories (gray area, based on Fowells 1965 and Elias 1980) in North America.

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